AUGUST 1959

Power Engineering

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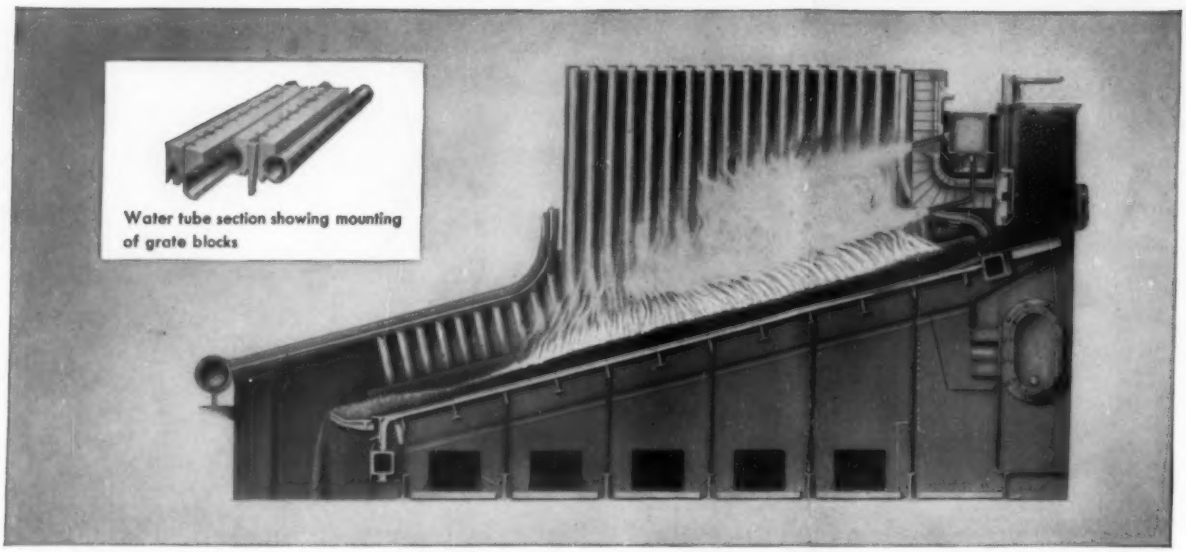

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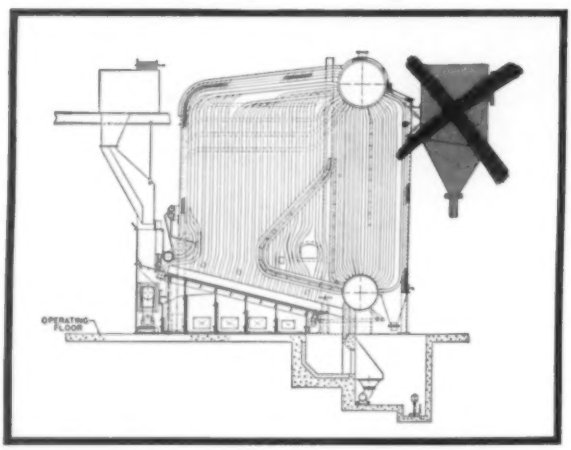

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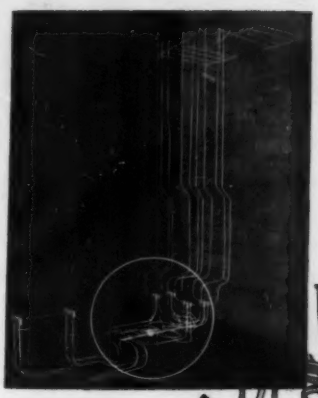

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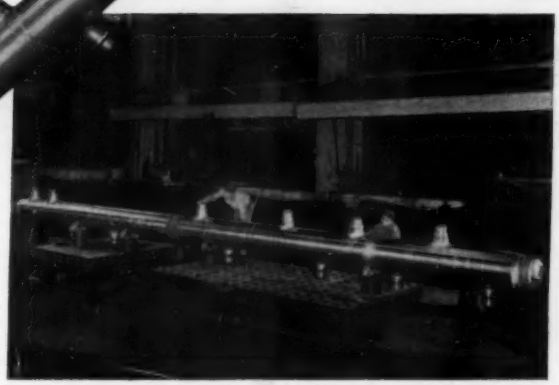

Stress analysis of a model of power piping is an established procedure at Pittsburgh Piping. It is used to predict accurately the physical reactions of high-temperature, high-pressure piping in service.

The photograph at top left shows a model of main steam piping which is part of a complete system shop fabricated and field erected by Pittsburgh Piping. The enlarged section of the model indicates the relative size and location of the main steam header. This header, shown in the main photo, is fabricated of Stainless Steel Type 316. It weighs 16,500 lbs. and its wall thickness is 3".

Model testing and shop fabrication are two phases of Pittsburgh Piping service which covers every aspect of a piping job—from blueprint through erection. We are specialists—thoroughly experienced in the theoretical and practical aspects, as well as in the code and insurance requirements of high-temperature, high-pressure piping.

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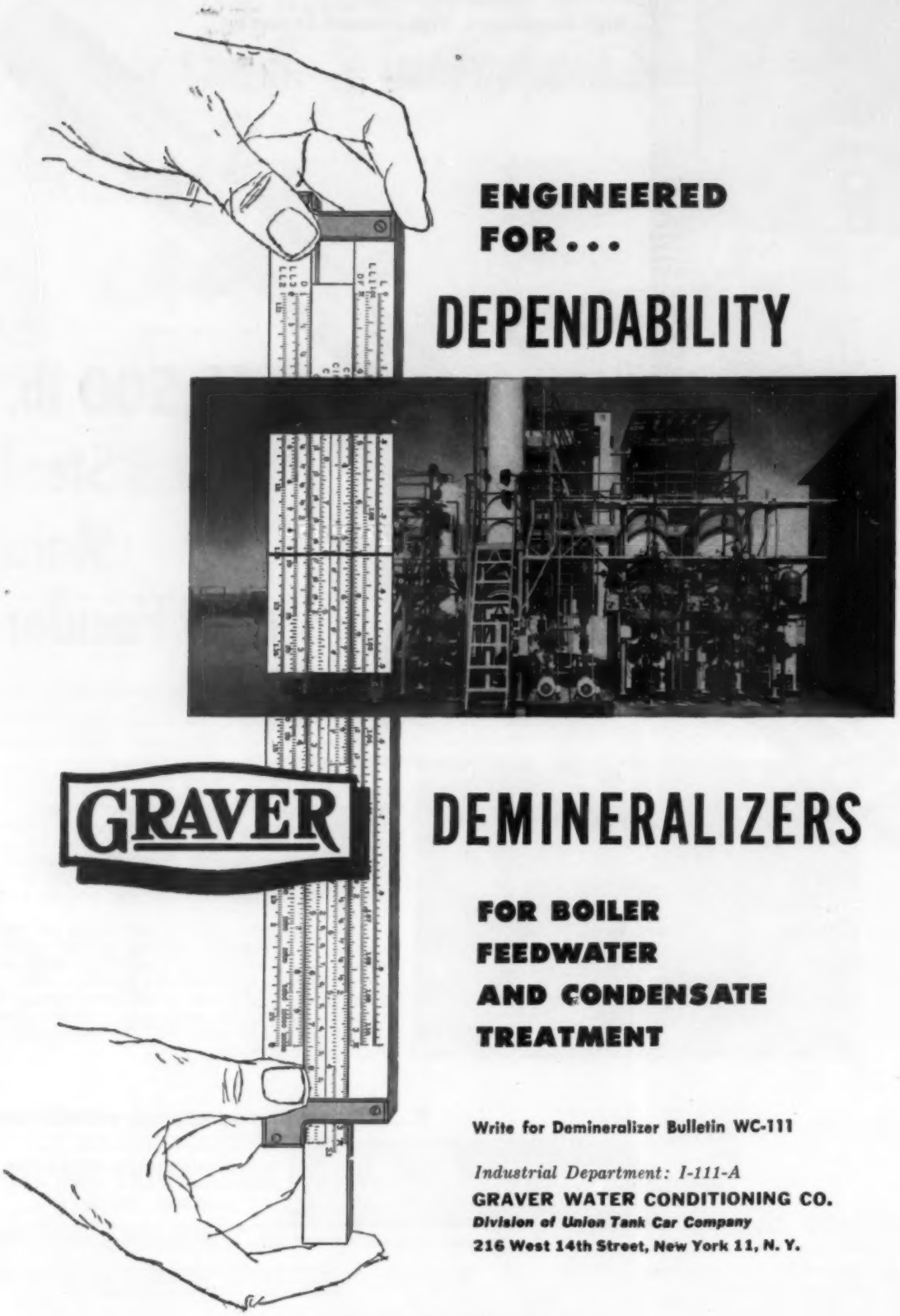

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

● 800,000 KW from one steam turbine-generator unit — it's been proposed by Westinghouse for TVA. The manufacturer has offered to build such a machine, which would be the largest in existence. Its electrical output would be enough to supply the residential needs of a city the size of Detroit at a capital cost to TVA for the machine of $30 per kw. It would be a cross-compound unit, with two inner-cooled generators each rated at 400,000 kw.

● **JOHN CRERAR LIBRARY, one of the world's largest collections of technical, scientific and medical literature, will move from its present building in downtown Chicago to the Technology Center campus of Illinois Institute of Technology.**

The Crerar Library will have custody of IIT's technical library collection and will be operated as a public library, A new building will be constructed on the IIT campus to house the Library. IIT personnel and students comprise the largest single group of users of the Crerar Library at this time.

The move will make possible expansion in the services of the Library, as well as economies in its operation.

● ZIMMERMANN PROCESS for the disposal of sewage sludge (see POWER ENGINEERING, January, 1959, page 88) has been adopted by the Metropolitan Sanitary District of Greater Chicago, and also by the city of Wheeling, W Va. Sterling Drug, Inc, whose engineers developed the process, will design, equip and build Zimmermann plants for both cities. Chicago plant will handle 200 tons of sewage sludge a day, will cost $11,870,000. Wheeling plant will handle 5.6 tons a day, will cost $284,000.

● **NATIONAL POWER CONFERENCE will be held September 27–30 at the Muehlebach Hotel, Kansas City, Mo. The local ASME and AIEE sections are in charge. Some 20 technical papers will be presented. One session and an inspection trip will be given over to Kansas City Power & Light Co's new Montrose Station.**

Sixth Electrical Conference of the Petroleum Industry will be held at the Wilton Hotel in Long Beach, Cal, August 23 through the 26th.

Fire Prevention Week will be observed this year from October 4–10.

U. S. oil industry will be 100 years old on August 27. It was on that day in 1859 that Colonel Edwin L. Drake brought in the nation's first commercial oil well near Titusville, Pa. American Petroleum Institute is leading a nation-wide centennial celebration which has been going on since May and will continue through the year, culminating at API's annual meeting in Chicago in November.

● PAUL R. DUFFEY, chief power engineer of Youngstown Sheet & Tube Co for many years, retired from that company and position on March 31. Shortly thereafter he joined Au-

Paul R. Duffey

burn & Associates, Inc, engineers, in the capacity of vice-president, sales for steam, power and auxiliary services for industry. This is a consulting-engineering organization with offices in Dalzell Bldg, 923 Penn Ave, Pittsburgh 22, Pa.

Mr. Duffey is well known in the power engineering field for his work with Youngstown and his activities in ASME. A native of Roanoke, Va, he attended Virginia Polytechnic Institute and University of Cincinnati,

receiving a degree in mechanical engineering. He earned his college expenses as a part-time mechanical supervisor and power engineer for the Norfolk & Western RR, and for Mathieson Alkali Works. During World War I he was superintendent of steam and electric power generation, Potomac District, U. S. Railroad Administration. Then he served with Celanese Corp, The Babcock & Wilcox Co, and American Maize Products Co. He joined Youngstown Sheet & Tube Co in 1940 and was made chief power engineer in 1946.

Mr. Duffey has been a leader in development of high-pressure, high-temperature industrial power plants. Since 1940, he has supervised construction for Youngstown Sheet & Tube Co of eight new high-pressure steam generating units and three turbine-generator units at the Indiana Harbor works, a new steam-generating station at South Chicago Works, blast furnace blowers, and steam generators at the Campbell Works and the necessary auxiliaries and control equipment for all these.

Mr. Duffey was largely responsible for re-activating the Youngstown Section of ASME, has been elected a Fellow of ASME, and has contributed many technical articles to POWER ENGINEERING and other national magazines. He is a member of Engineers' Society of Western Pennsylvania and of NSPE, and is a registered professional engineer in Ohio, Indiana, Missouri and Virginia. He makes his home at 586 Tod Lane, Youngstown, Ohio.

MORE ON COOLING TOWERS will be forthcoming soon in POWER ENGINEERING, stimulated by interest in J. F. Van Rysselberge's article in June on hyperbolic towers. We plan to extend this study of the European form of tower with figures and tables which will give a fuller picture of operating costs of hyperbolic vs conventional cooling towers.

By way of correction, will readers of the June article (page 96) please note that paragraph five states that "ribs on the inner surface of the tower are optional . . ." The word "inner" should be omitted from the sentence. Also, in Table I, the figures for Total Area Occupied should have read 38 acres (for mechanical draft) and 10 acres (for natural draft).

J. EARL HARRINGTON, executive secretary of Western Society of Engineers, has resigned that position. As of this writing, a management committee of the board of trustees is handling the affairs of the Society and expects to announce a new secretary before the fall season. The April, May, June and July 1959 issues of the *Midwest Engineer*, a magazine published by WSE, were suspended, but publication of the regular issues, it is stated, will begin again with the September issue. R. H. Bacon, president of R. H. Bacon & Co and a member of the Board of Trustees, will serve as Publishing Director. The quarters of the Society, at 84 E. Randolph Street, Chicago 1, are being given a complete renovation and the Society's dining room has been placed under a new operating plan.

MARTIN FRISCH, vice-president and director of advanced engineering, Foster Wheeler Corp, passed away on June 16. Born in Csebze, Hungary on November 22, 1899, he came to the United States in 1909. He received a BS-ME degree at the University of Illinois in 1921. Mr. Frisch was an author, lecturer and inventor holding over 50 patents in fuel pulverization, steam generation, combustion, manufacturing methods and other areas of heat engineering.

He joined Foster Wheeler in 1929 and was successively chief engineer of the pulverizer division, chief engineer of the steam division, director of engineering and development, vice-president and chief engineer, general manager of the equipment division and finally director of advanced engineering. He was also a vice-president and director of General Regulator Corp. Author of numerous technical papers and articles, Mr. Frisch was a fellow of ASME and a member of the American Society of Naval Engineers, the ASTM, and the Welding Research Council.

LARGEST COMPRESSOR construction program in company history, plus substantial addition to its pipeline system, is being carried out this year by Tennessee Gas Pipeline Co at a cost approaching $69,000,000. This will mean delivery capacity increased to more than 2.5 billion cu ft on average days and 2.9 billion on peak days, using underground storage.

Pipeline contracts totaling 201 miles of line in Tennessee, Kentucky and West Virginia have been let. The compressor construction work calls for the addition of 113,100 hp to the system through four new stations and enlargements of 13 existing stations. This will expand the present 641,300 hp of the system by about 18 per cent.

HONORS: F. L. LaQue, vice-president and manager of International Nickel's development and research division, has been nominated for the 1959–60 presidency of the American Society for Testing Materials.

Horace C. Blenkhorn has been elected president of the National Industrial Service Association, Inc, international trade organization of electric motor service and sales shops. Blenkhorn is president and general manager of the firm of Blenkhorn and Sawle of St. Catharines, Ontario.

Harvey F. McPhail, manager of the hydroelectric division of The Kuljian Corp, has received the Distinguished Nevadan Award from the University of Nevada.

John D. A. Morrow, consultant and director of Joy Mfg Co, has been given the 1959 BCR Annual Award for outstanding leadership on behalf of industry-sponsored coal research. This was the seventh annual award to be presented by Bituminous Coal Research, Inc.

PROPOSED MERGER of the Foster Wheeler Corp into North American Aviation, Inc, has been canceled. Detailed studies of the two companies' operations since merger talks were started last spring have resulted in the conclusion that the mutual benefits originally expected from the merger would not be realized.

BIGGEST hydroelectric project in the world is the dream of Senator Ernest Gruening of Alaska. He is proposing a dam on the Yukon River, 90 miles northwest of Fairbanks, which would create a lake the size of ake Erie. Power capacity would be an estimated 5,000,000 kw, and estimated cost to the Federal government would approach a billion dollars.

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FOR THE ELECTRICAL INDUSTRY

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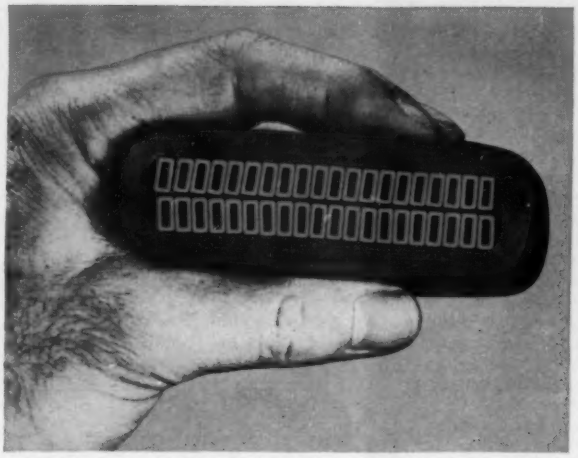
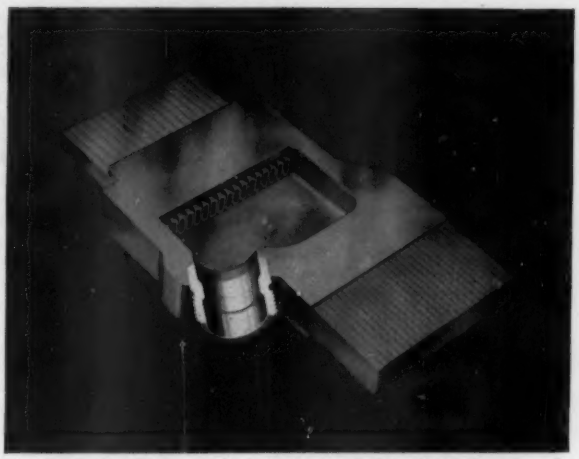


CROSS-SECTION of stator bar showing arrangement of 40 rectangular copper tube conductors which carry current and coolant—transil oil in present designs, water in units being planned.



LIQUID COOLANT enters the tubular conductors through a strand header at end of stator bars. *Above:* Header cut open to show construction. *Below:* Headers being installed on stator bars.

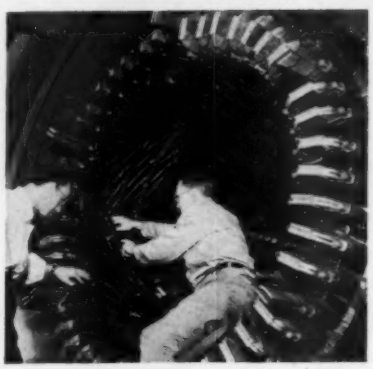
DO YOU KNOW THESE ELECTRICAL COPPERS?

ANACONDA LEADED COPPER-126 (Cu 99.00%, Pb 1.00%). Combines high conductivity, averaging 99% I.A.C.S., annealed, with excellent machinability, 80 on a scale in which Free-Cutting Brass is 100. Available in strip, rod, and bar form.

ANACONDA TELLURIUM COPPER-127 (Cu 99.49%, Te 0.50%, P 0.01%) offers high conductivity averaging 95% I.A.C.S., annealed, and machinability rating of 80. Available in rod, bar, extruded shapes, and die-pressed forgings. Particularly valuable where hot forging or hot working is combined with machining.

WRITE FOR Publication C-25, "Anaconda Copper for Electrical Conductors."

Liquid-cooled tubular copper conductors for stators can double generator ratings



In designing turbine-generator units for the ever larger blocks of power needed by the electric utility industry, General Electric scored a major advance by liquid-cooling the conductors in generator stator bars. The problem has been to increase generator ratings without increasing their physical size beyond the limitations of transportation.

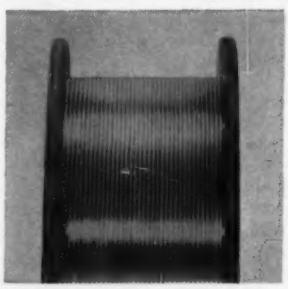
Occupying no more space than conventionally cooled 156,250-kva units of a few years ago, the first conductor-cooled G-E generator has a rating of 260,000 kva. And this new design is a significant step toward doubling generator ratings without an appreciable increase in frame size. It points the way to much larger machines – possibly as high as 750,000 kva.

The French Small Tube Division of The American Brass Company has recently supplied rectangular copper tube conductors for another generator of this design, which will have a rating of 221,000 kva. The tube was shipped in long coils.

For technical assistance in the design of hollow conductors, write The American Brass Company, Waterbury 20, Connecticut.

8970

Anaconda Welding Wire now available on 25-lb. spools for inert-gas consumable-electrode welding



For welding copper bus conductors and other fabrication by inert-gas consumable-electrode processes, Anaconda Copper-372 Welding Wire is now available in 25-lb. expendable spools. Carefully cleaned and layer-wound (left), it is shipped in a special carton. Sizes regularly available on spools: .035″, .045″, 1/16″, 3/32″ and 1/8″. Other Anaconda copper-alloy welding alloys, such as Everdur®-1010 and Ambraloy®-928, also are supplied on spools. For detailed information on Anaconda Welding Rods, write for Publication B-13.

For more data circle 504 on Post Card

WHAT THEY TELL US

▶ **WHEN READER E. K. STOCKER** brought it to our attention, we belatedly realized that it is indeed very difficult to cool gases to 125 F with 150 F water! Said Mr. Stocker:

> In an article by E. E. Kimball, page 86 of the May, 1959 issue of POWER ENGINEERING, a very wonderful economizer was described. Its name — Operation Bootstrap — was quite appropriate and we would like to know more about it.
>
> Water enters this economizer at 150 F and reduces the diesel exhaust gas temperature to 125 F. We are anxious to know how this is accomplished.

We immediately contacted the author, and as we suspected, there was more to the story than was brought out in the article. Mr. Kimball explains:

> The water enters this economizer at 150 F only when we wish to make all the steam possible, which is only on Saturdays, when the plant is not running. At this particular time we can use only part of the hot water; we can always use all of the steam.
>
> When the plant is running we use all the hot water we can make. At this time, the water enters the gas exit end of the economizer at city temperatures of from 40 F in the winter to 70 F in the summer. This heated water then goes partly to plant process as is.
>
> In this economizer, as stated, there are ten separate sections of four coils each, and water can come to any one or any number of these coils from the following: city meter, waste heat boiler, oil cooler and water jacket.
>
> By the same token, the outgoing water can come through to the waste heat boiler or to our process.

▶ **MAXIMUM NET EARNINGS** for the small industrial power plant is an all-important consideration at the plant design stage. Andrew A. Cummins, consulting engineer in Ann Arbor, Mich, discussed the practical implications of this subject in the December, 1958 issue, page 70. Cummins' views on by-product power production have stimulated comment from Henry D. Fisher, of New Haven, Conn, also a consulting engineer with long experience in power plant design. Fisher writes:

> I feel that the author is somewhat over-enthusiastic about the scope of industries and range in size of plants where by-product power production is desirable, and that the engineering adviser should be somewhat more cautious in his recommendations than the author would seem to indicate.
>
> Current trends in many of the factors affecting by-product power production are narrowing the field where such installations are profitable, as compared with other alternatives for supplying the same services; and these unfavorable trends seem likely to continue for quite a while yet.
>
> Among the factors in which those unfavorable trends are most evident are: 1. increasing ratio of power to process steam requirements in most industries; 2. more rapid rate of increase in price of items entering into cost for self-generated power than in purchased-power rates.
>
> For example, in paper board manufacture, traditionally the most advantageous sector of the paper industry for by-product power installations, power consumption per ton of finished product has risen from about 200 kwh in 1928 to 360 kwh in 1944 and 530 in 1956-57 in one reasonably representative mill, while steam requirements remained substantially constant at 13,000 lb per ton of board. With steam at 400 psi and 650 FTT, the balance point of no wasted exhaust for a 3500-kw turbine generator worked out at about the 300 kwh per ton level.
>
> Of course, higher steam pressure and temperature will raise the balance point somewhat but only so far, and with the quality of supervision usually available, increased difficulties in maintaining adequate feedwater purity are certain.
>
> Bleeder-type condensing turbines are possible but only at locations where condensing water is available, and even then, in moderate-sized units, comparatively high steam rates and increased auxiliary power consumption make the self-generated power rather high cost.
>
> Costs of power equipment like everything else have risen and the end does not seem in sight. According to the Edison Electric Institute, the rates per kwh for power purchased by large industrial consumers reached a low point around 1943–44 and have since risen perhaps 20 to 25 per cent. On the other hand, one of the more generally used indexes of cost of power plant equipment has risen from a little below 100 in 1943–44 to about 230 today. This results in a corresponding increase in fixed charges on an industrial power plant installation.
>
> A further drawback in realizing the savings to be expected from a by-product power cycle arises from the necessity of providing excess capacity in the initial installation for growth in steam and power demands over the reasonably foreseeable future.
>
> Additional hazards threatening the owner are those arising from sudden changes in consumer preferences and production methods, which seem to be now more frequent and of greater magnitude. Thus, it is desirable to keep unrecoverable investment to a minimum, and while durable equipment should be provided which will if called on provide dependable service for 20 years or more, it is best to limit expenditures for cost reduction to those which offer a good prospect of paying out in the near term of perhaps, considering all the uncertainties including those of engineering estimates, five years or so.

Andrew Cummins will reply to these comments by Henry Fisher, in an early issue of this department.

▶ **FOOD FOR THOUGHT** in the May issue has stimulated reader John H. D. Blanke to comment:

> As customary in previous months, I perused the pages of the current issue of POWER ENGINEERING (May, 1959) within a few hours after it reached my desk. In my search for statements that direct the engineer's mind into the problems of tomorrow, I find your three-page article on the underground gasification of lignite most rewarding; and your editorial comment on directing research dollars into the power resources field is timely indeed. In the contest for survival between nations during the centuries to come, the availability of fuel will be a major factor in victory.
>
> Your one-page article, Do Power Plants Pollute the Air?, is thought-provoking, indeed. The observing city dweller must admit that through the years the stacks of power plants and industrial plants have developed a lighter, cleaner plume, but the motor vehicles are spreading a noxious haze from their exhaust pipes. It is time to take the frills off the automobile and install a catalyzer to produce a pure exhaust.

▶ **NOTE** from Arthur E. Hill of Long Beach, Cal, brings us up to date on affairs of the American Power Dispatchers Assn. Hill tells us that:

> At a meeting held in the Lafayette Hotel in Long Beach, officers were elected for 1959–60. Those elected were: president, F. E. Niemeyer, California Electric Power, San Bernardino; vice-president, J. L. Price, Southern California Edison Co, Los Angeles; secretary, C. B. Wade, Los Angeles Dept of Water and Power; treasurer, R. W. Stinebaugh, Pasadena Municipal Light and Power.

Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

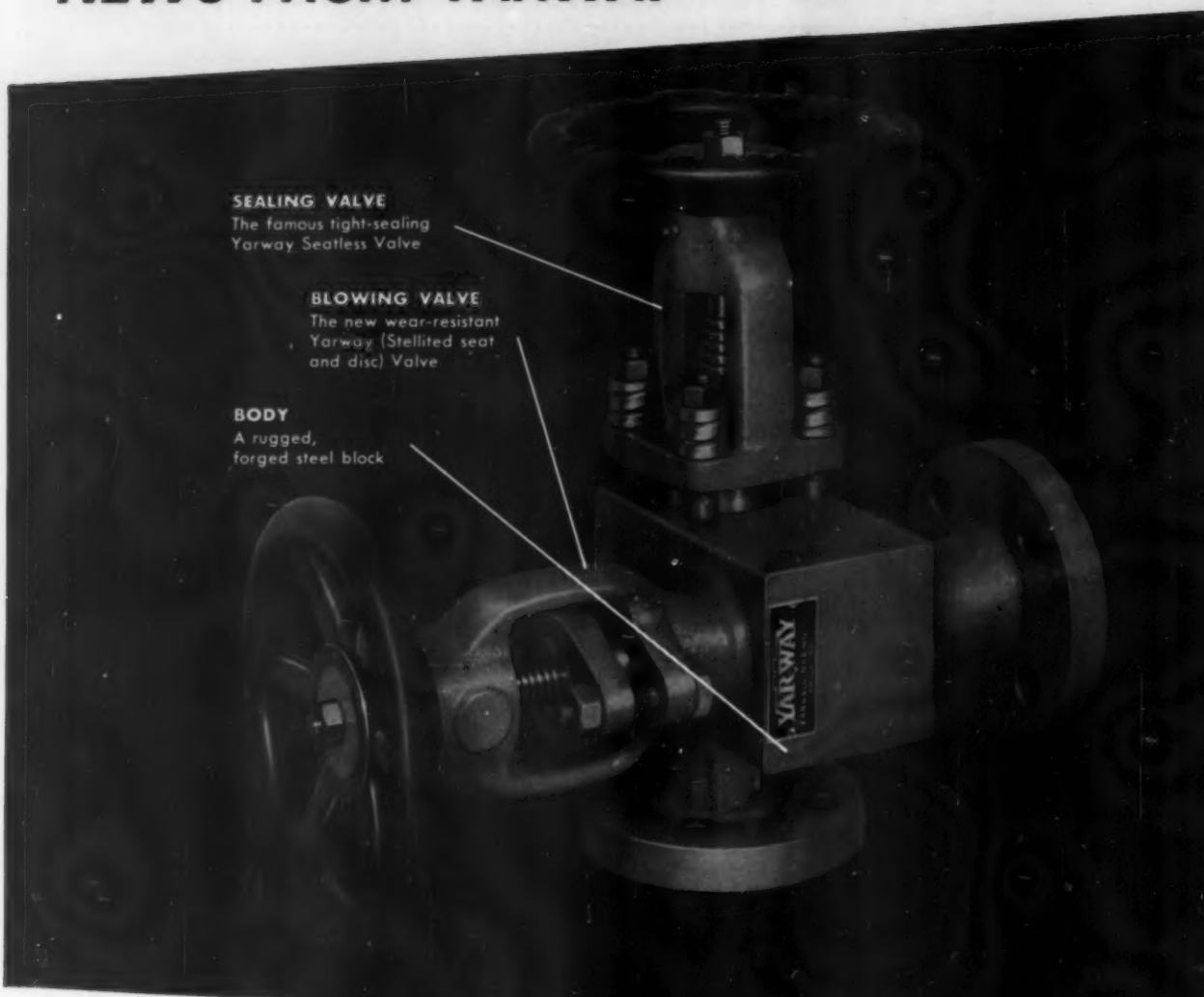
The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

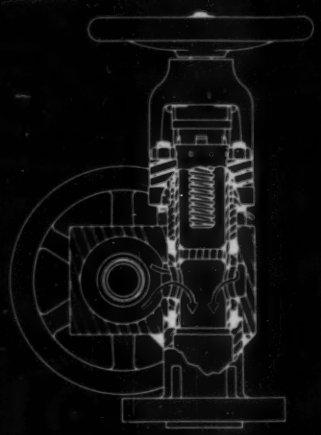
8108 Maple Street Three Rivers, Michigan

For more data circle 505 on Post Card

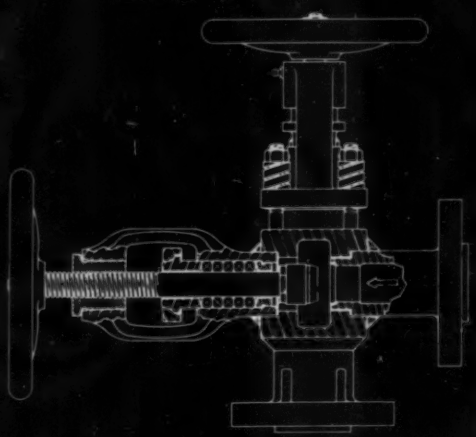
NEWS FROM YARWAY



NOW! A NEW YARWAY BLOW-OFF VALVE FOR



Cross-section showing seatless sealing valve in open position. Flanged ends shown, welding ends also available.



Cross-section of medium pressure Unit Tandem Valve showing hard-seat blowing valve in open position.

UNIT TANDEM MEDIUM PRESSURE BOILERS

There's a new star in the Yarway Blow-Off Valve line.

For years rugged Yarway Unit Tandem Blow-Off Valves have been standard equipment on most high pressure boilers. In fact, more than 80% of high pressure plants use Yarways.

Now a *new design* Unit Tandem is offered for *medium pressure boilers to 665 WSP.* Streamlined, lighter in weight, easy to operate, tight sealing and long wearing —this valve brings premium quality Yarway Unit Tandem dependability to the medium pressure field— *at a competitive price!*

Important features, like the nitralloy plunger in the sealing valve and integral stellite seat and disc in the blowing valve, make this your best buy for blow-off service.

Order Yarway Unit Tandems for your present boilers— or specify them on new boilers.

For full details write for Yarway Bulletin B-435, Supplement A.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCHES IN PRINCIPAL CITIES

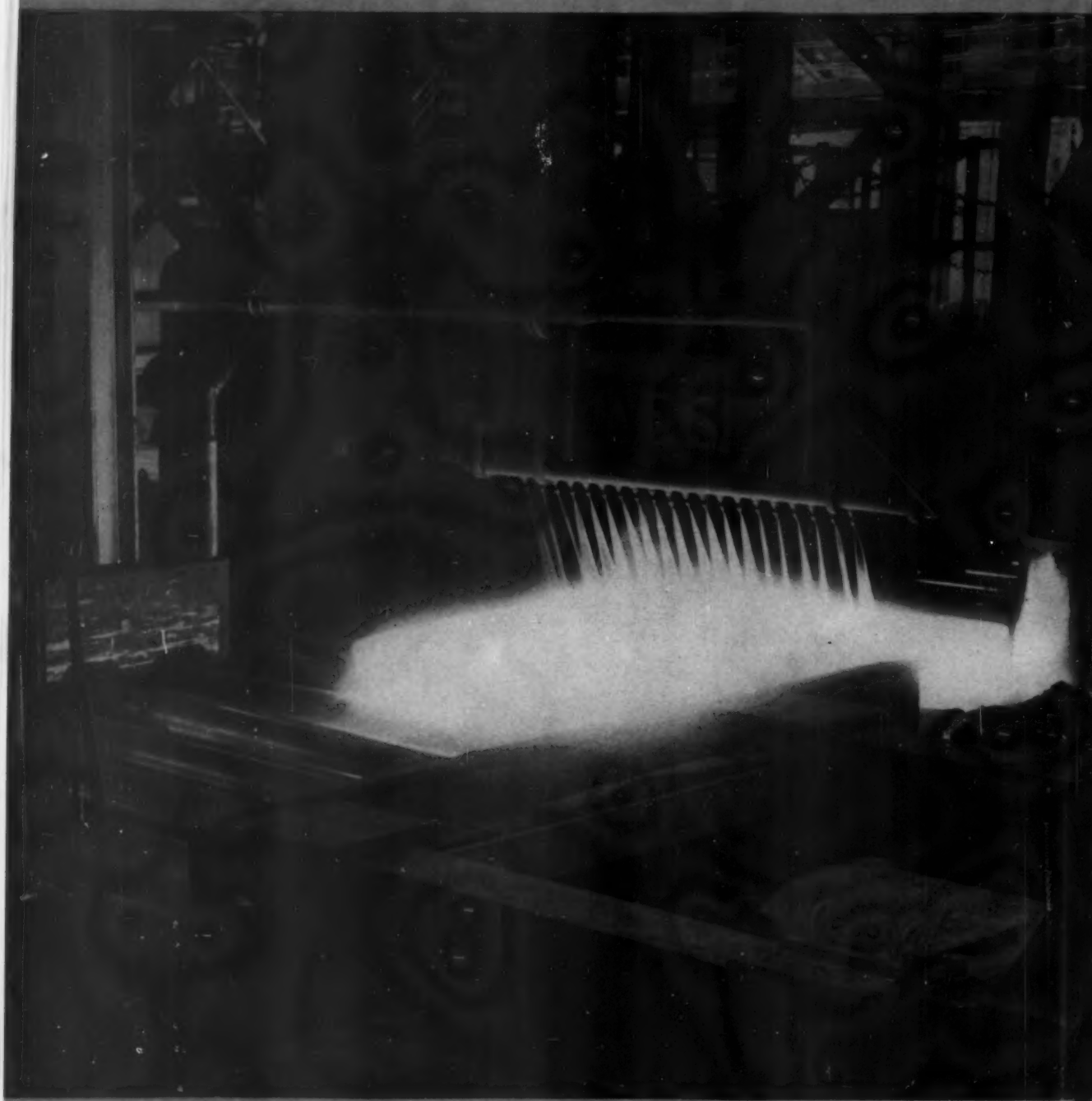
YARWAY®

For more data circle 506 on Post Card

DE LAVAL

CENTRIFUGAL PUMPS

for high-pressure

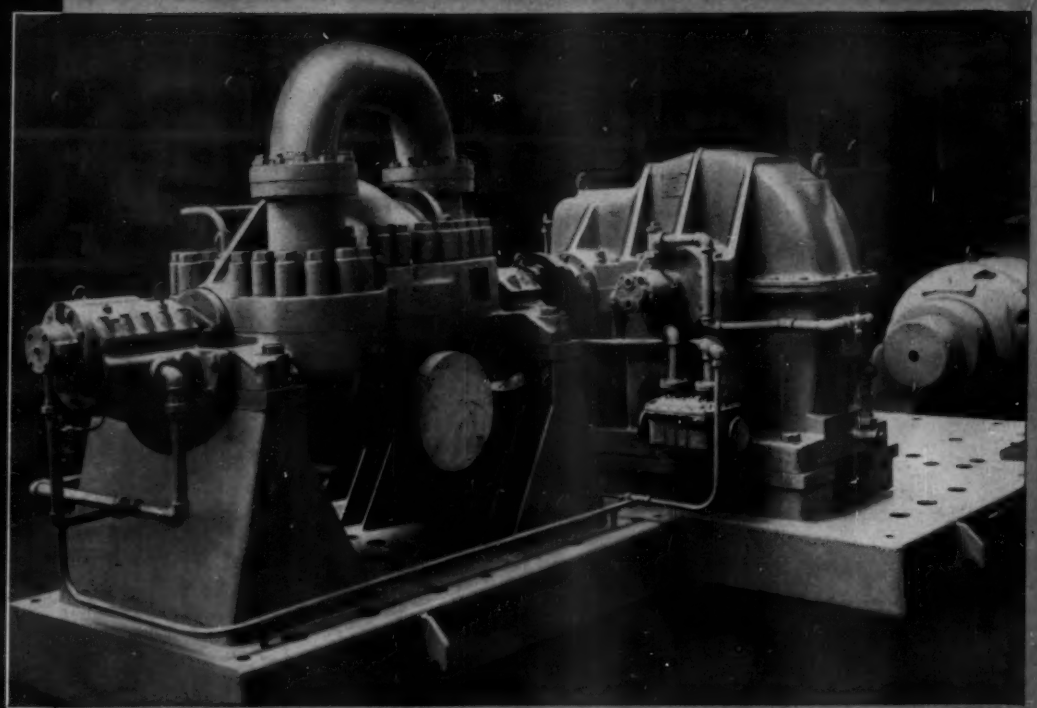


descaling at Lukens Steel

Latest successful technique of high-pressure descaling is now being performed in this modern steelmaking facility designed by Mesta Machine Co.

The initial high-pressure descaling operation uses De Laval split-case multi-stage pumps as shown in the photograph below. Each pump supplies cold water at 1000 gpm and 1600 psig. Electric motors rated at 1750 hp drive the pumps through speed increasers which raise the speed from 1200 rpm to 4250 rpm.

De Laval pumps also serve Lukens on a 1200 psig descaling system in another section of the Coatesville, Pa. mill.



One of several arrangements available for descaling service at pressures of 1000-1200-1600 psig and capacities to 2200 gpm.

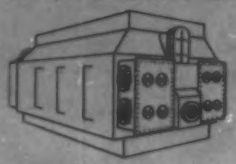
DE LAVAL *Steam Turbine Company*

816 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

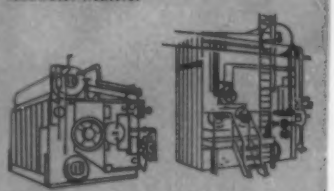
DL470

Power Plant Products

HEAT ENGINEERED BY FW

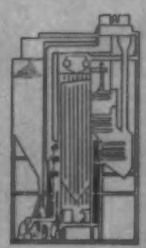


CONDENSERS and HEATERS—Condensers custom designed for individual plant requirements. All-welded high and low pressure feedwater heaters.



PACKAGED and FIELD-ERECTED BOILERS—Compact, economical, standardized units in capacities from 10,000 to 450,000 lb/hr oil, gas or pulverized coal fired.

LARGE STEAM GENERATORS—Designed to meet all requirements for Central Station or industrial power plants, in single- or twin-furnace designs, with or without reheat or dual circulation.



COOLING TOWERS—Induced draft counter-flow towers of all-redwood construction for maximum dependability and long service.

NUCLEAR COMPONENTS—Heat exchangers, steam generators, pressurizers, reactor vessels, separately-fired superheaters for stationary and marine power plants.

PULVERIZED FUEL SYSTEMS—Completely engineered systems utilizing FW ball mill or MB planetary roll and table pulverizers.

HEAT ENGINEERING

SIMPLIFIES LAYOUT and

WITH NEW SINGLE-PASS,

Compact shells use economical short tubes, eliminate two waterboxes, simplify valving. Balanced back pressure and built-in backwashing system offer further advantages for Alabama Power Company's Barry Steam Plant, Unit No. 3.

Problem: Alabama Power Company and Southern Services, Inc., Engineers, specified that the dual exhausts of the 225,000 kw turbine be handled with condenser tubes at right angles to the turbine shafts —in the tight confines of a plant extension for Barry Steam Plant, Unit No. 3.

Solution: Heat Engineering by Foster Wheeler

By application of the established principles of Foster Wheeler condenser design, a most economical arrangement for a twin bottom-exhaust turbo-generator set with tubes at right angles to the turbine shafts was provided. It features short tube lengths, complete backwashing and a minimum number of waterboxes for a twin-shell design.

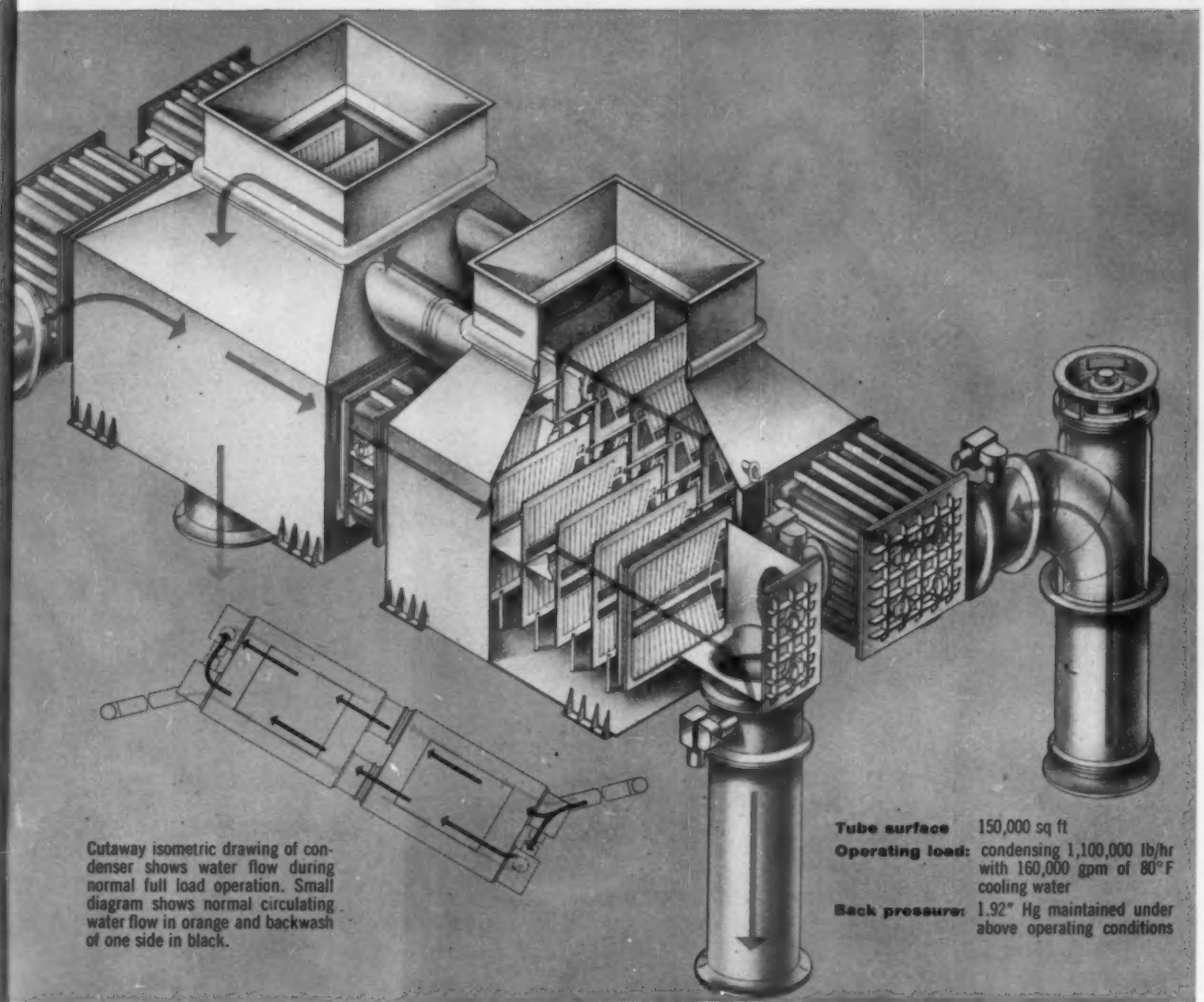
Backwashing of the tube sheets is obtained with only six valves, two of which are the normal circulating pump shut-off valves. This valving arrangement also allows the complete condenser to be operated at light loads with only one circulating pump.

In design advances such as this, you see Heat Engineering at work. This is the concept you can expect—combining new and original ideas with proved engineering principles—when Foster Wheeler serves you. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.*

BY FOSTER WHEELER

REDUCES CONDENSER COSTS

COUNTER-FLOW DESIGN



Cutaway isometric drawing of condenser shows water flow during normal full load operation. Small diagram shows normal circulating water flow in orange and backwash of one side in black.

Tube surface 150,000 sq ft

Operating load: condensing 1,100,000 lb/hr with 160,000 gpm of 80°F cooling water

Back pressure: 1.92" Hg maintained under above operating conditions

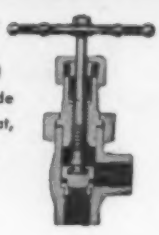
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

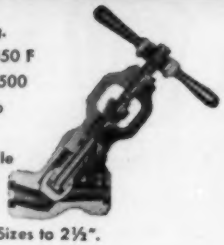
For more data circle 508 on Post Card

EDWARD FIG. 848
GLOBE VALVE
ILLUSTRATES
VALVE SELECTION PRINCIPLES

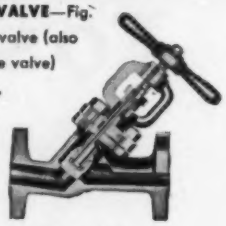
1 ANGLE VALVE—Fig. 2699, 600 lb at 900F (2000 lb WOG) with union bonnet, inside screw, replaceable seat, knobbed handwheel, and screwed ends. Sizes ¼" to 1".



2 UNIVALVE*—Fig. 2224, 1500 lb. at 1050 F (3600 lb WOG) or 2500 lb at 1050 F (6000 lb WOG) with outside screw, Impactor* handle seal-welded bonnet, integral seat and socket welding ends. Sizes to 2½".



3 BLOW-OFF VALVE—Fig. 641, straightway valve (also available as angle valve) 300 lb at 850 F, 600 lb at 850 F, 1500 lb at 850 F, with integral Stellite seat, flanged ends, bolted bonnet. Sizes to 2½".



What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

HOW TO SELECT FORGED STEEL VALVES

When you need forged steel globe or angle valves (2½" and smaller) for high-pressure and/or high-temperature applications, you can save money on your installations as well as reduce future maintenance expense by making sure you select the proper valve. Here are a few suggestions.

VALVE CONSTRUCTION DETAILS
(See large illustration, opposite page)

Valve Handwheel or Handle should be large enough to operate valve easily. Wheel spokes help keep handwheel cool. Knobbed design permits tight grip even with greasy gloves. Impact type handle will be helpful in obtaining tight closure for valves 1½ to 2½ in.

Yoke Bushing material should be checked. High-strength aluminum bronzes are usually best. Look for ample thread engagement between bushing and yoke and between bushing and stem.

Gland-Stuffing Box—Stuffing box with bolted gland assures good packing compression; hinged bolts swing out of the way but don't get lost. Be sure to get stainless steel bolts for maximum resistance to rusting, and for easy adjustment even after years of service. Packing chamber should be deep and not excessively wide.

Bonnet Joint of bolted construction is easiest to work with. You can disassemble and reassemble with pocket-size tools. Union bonnet is compact and usually less expensive for smaller valve sizes, but is not recommended for high temperatures. Bonnet gasket of soft iron performs well in most services but spiral wound metallic-asbestos gaskets are superior in high temperature services. For extreme pressure-temperature services welded bonnet joints for permanent tightness are desirable. Seal-welded type bonnet has advantage over fully welded design because it permits disassembly and reassembly.

Seat-Disk Joint—An integral hard-faced seat is generally regarded as superior to screwed seat construction because it eliminates body-seat leakage and retains hardness under temperature. A hard faced disk or disk of special alloy is desirable in high temperature services; but 13 per cent chromium stainless steel is an excellent all purpose material below 750 F.

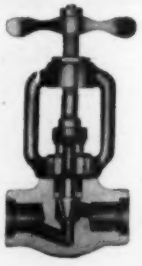
Other Features to Evaluate—Valve compactness is important because you frequently find small piping located in crowded quarters. Inclined bonnet globe valves are less likely to erode due to high velocities—have less pressure loss. Valves of "inside screw" design (stem threads below packing chamber) are usually lower priced and give good service where temperature is not too high and where line fluids are free of sediment. But, best design and materials are useless without experienced workmanship and rigid quality control.

VALVE APPLICATION SUGGESTIONS
First, determine whether a standard valve will do the job before ordering expensive special designs. (Your Edward Representative can help you decide.) Often a slight modification of a standard valve, or a combination of standard valves, will do the job. Here are some facts about types of standard valves and their application:

- For many services, angle valves (illustrated by valve #1) reduce installation cost, minimize pressure drop, improve operational convenience. All Edward forged steel stop and stop-check valves from ¼" to 2½" sizes are available in the angle version.
- For high temperature, Edward forged steel valves with seal-welded bonnets (#2) permanently maintain pressure tightness without periodic tightening of bonnet joints.
- For blow-off service, or wherever double valving is required, select sets of valves of the same basic type with hard-faced seating surface for dependability, longer life and interchangeability of parts (#3).
- For permanent tightness, select an instrument valve (#4) with corrosion-erosion resistant hard-faced seat or a valve with stainless steel body. Bonnetless design requires less maintenance.
- Piston-type check valve (#5), available with union, bolted, or seal-welded cover, is best for most services because it will seat tighter, has easily repairable seat face.
- Modern globe and angle stop valves (shown here) are more dependable than gate valves where repeated drop-tight closures are required, may be used for approximate flow regulation and moderate throttling.

YOUR EDWARD REPRESENTATIVE will be glad to give you the complete story on these features, plus the many other advantages of Edward valves—such as positive, pressure-tight backseats, self-centering disks, special stem and packing materials, and many others. Edward builds a complete line of cast and forged steel valves for pressures to 10,000 lbs. For additional information write to Edward Valves, Inc., 1202 W. 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

4 INSTRUMENT VALVE—Fig. 952Y, 600 lb or 2500 lb at 850 F (6000 lb WOG) with swing bolted gland, socket welding ends, no bonnet joint. Sizes ¼" to 1".



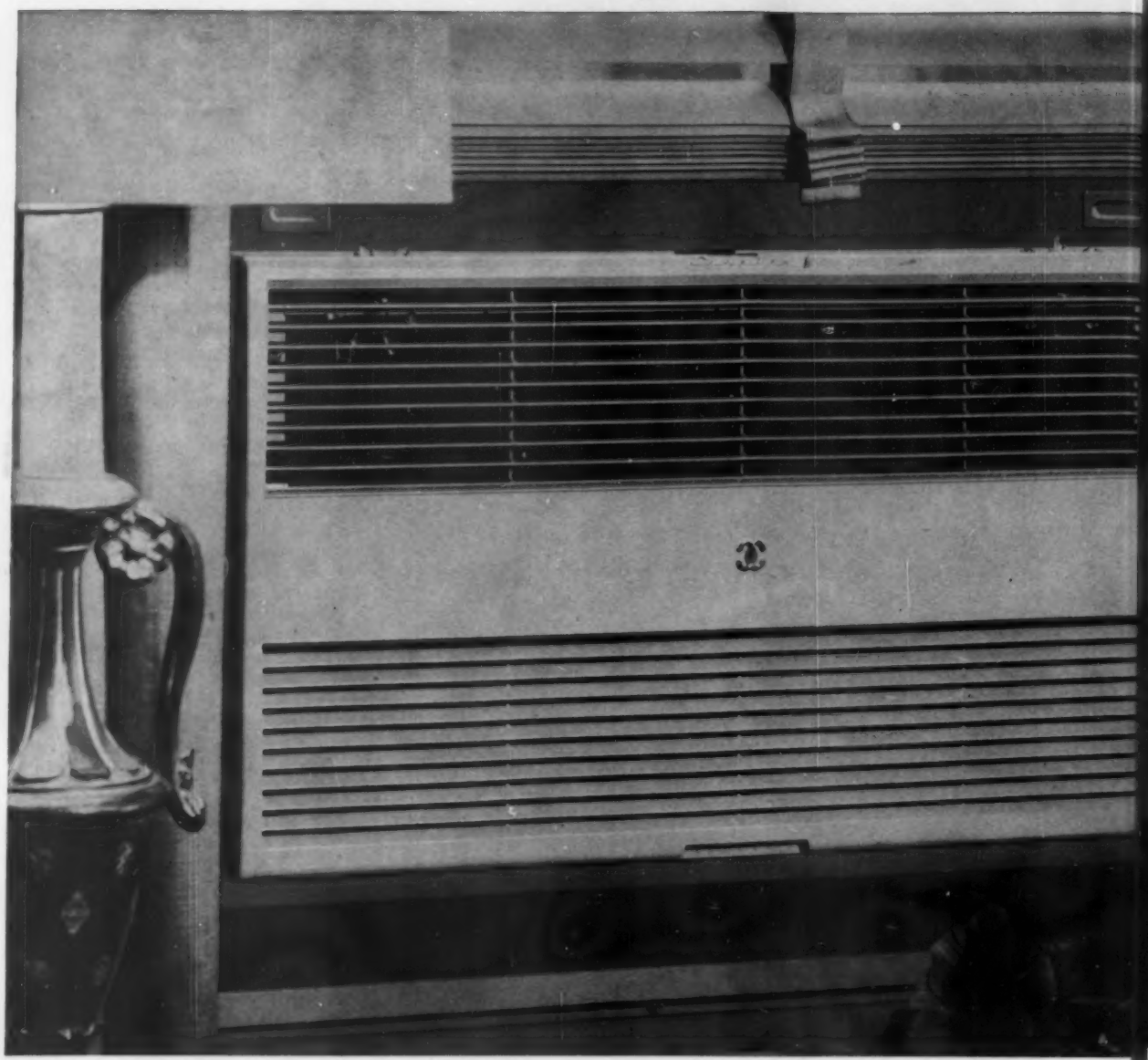
5 CHECK VALVE—Fig. 5538, piston type, 1500 lb at 1050 F (3600 lb WOG) bolted bonnet, screwed ends, integral Stellite seat. Sizes ¼" to 2".

*T. M. Reg. U. S. Pat. Off.

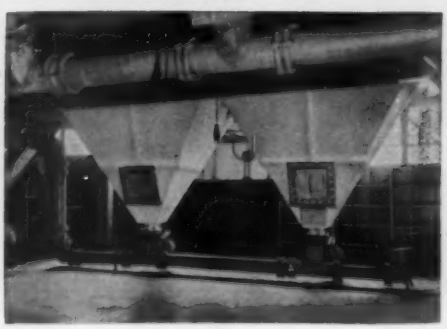
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

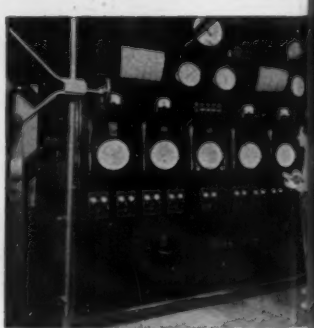
For more data circle 509 on Post Card



General view of Carrier power plant. Boilers on right are bent tube, two-drum types, by Riley Stoker Corp. burning pulverized coal. Coal moves from bunkers to Riley Pulverizers (at left in photo) and then into furnace.



Mechanical dust collectors by Prat-Daniel Corp. help assure cleanliness of operation. These collectors tie in with United Conveyor ash handling system for movement to ash silo and final disposal.



Pneumatic automatic control panel by Bailey Meter Co. regulates combustion operation of all boilers and auxiliary equipment, maintains continuing steam generation efficiency!

Carrier puts the chill on fuel costs...with coal

Air conditioner manufacturer uses coal for low-cost steam

An unusual team—the heating ability of coal and the cooling facility of air conditioning equipment! Yet Carrier Corporation, Syracuse, N.Y., found this combination profitable when expansion plans required additional capacity in its steam plant. After engineering surveys, Carrier decided to continue burning coal for economy of operation. Today modern power equipment supplies steam *economically* for heating, air conditioning and processing. Original fuel costs plus automatic operation within the power plant hold overall steam costs to a minimum.

Coal is lowest cost fuel

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% *more* steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for our case history booklet, complete with data sheets. You'll find them informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

BITUMINOUS COAL INSTITUTE

Dept. PE-08 Southern Building, Washington 5, D. C.

See our listing in *SWEET'S*

Coal is loaded into silos before it moves to bunkers. At left is the ash silo which utilizes rotary dustless unloader in loading trucks for disposal. Silos and conveyors are by Fairfield Engineering Co.

SEND COUPON FOR NEW BCI PUBLICATIONS. Guide Specifications, with complete equipment criteria and boiler room plans:

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Gentlemen: Please send me:

☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker); ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker); ☐ GS-3 (automatic package boiler for heating and process plants). ☐ Case histories on larger plants.

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Title_____

Company_____

Address_____

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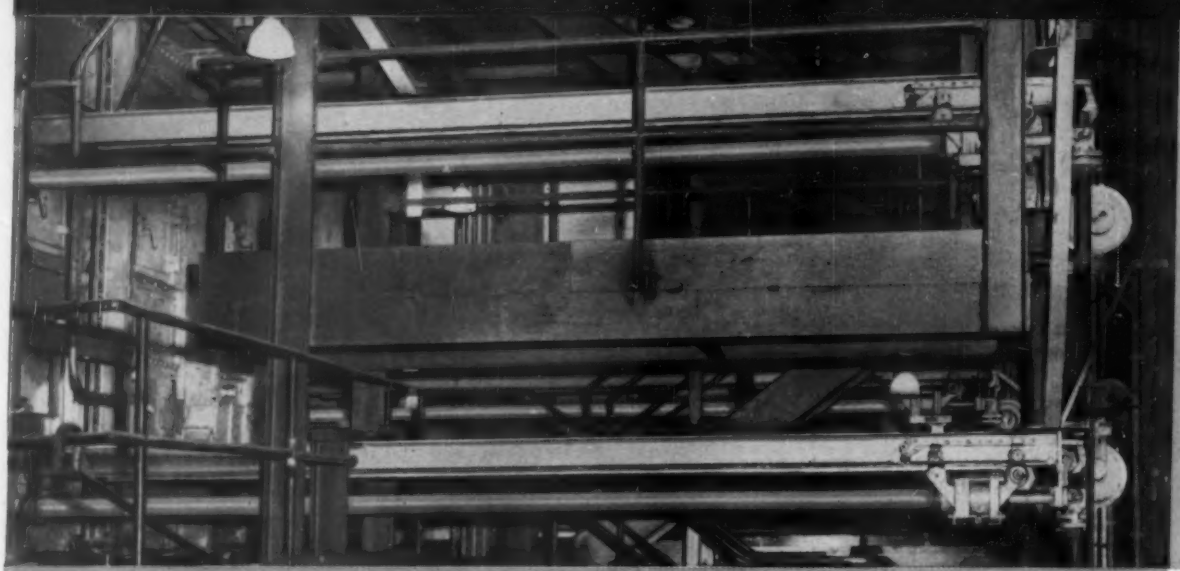
AT F.M. TAIT STATION, DAYTON POWER & LIGHT CO.

BOILER CLEANING IMPROVEMENT HELPS MODERNIZATION PROGRAM

SAVE $40,000

DIAMOND BLOWERS and AUTOMATIC



Three of the Diamond Model IK Long Retracting Blowers installed to replace manually operated rotary blowers. Electric motor driven, they are controlled by the Automatic Sequential Panel. Air is used as the blowing medium. Rotary elements were retained in cooler locations and motorized for automatic operation and are also controlled by the Automatic Sequential Panel.

In the continuous struggle to cut operating costs, the Dayton Power & Light Co. has found a very useful tool in "Boiler Cleaning Modernization."

By applying the latest soot blowing equipment to four of their boilers at the F. M. Tait Station, together with other features of the modernization program, the Dayton Power & Light Co. was able to reduce the operating costs on these boilers by some $40,000 per year and also cut blower maintenance costs.

On the first boiler that had its cleaning modernized, 17 rotating elements were removed; the remaining seven blowers of this type were electrified for automatic control. The cleaning equipment added consisted of five Long Retracting Blowers and six Short Retracting Blowers. All blowers are automatically controlled by a Diamond Selectromatic Panel.

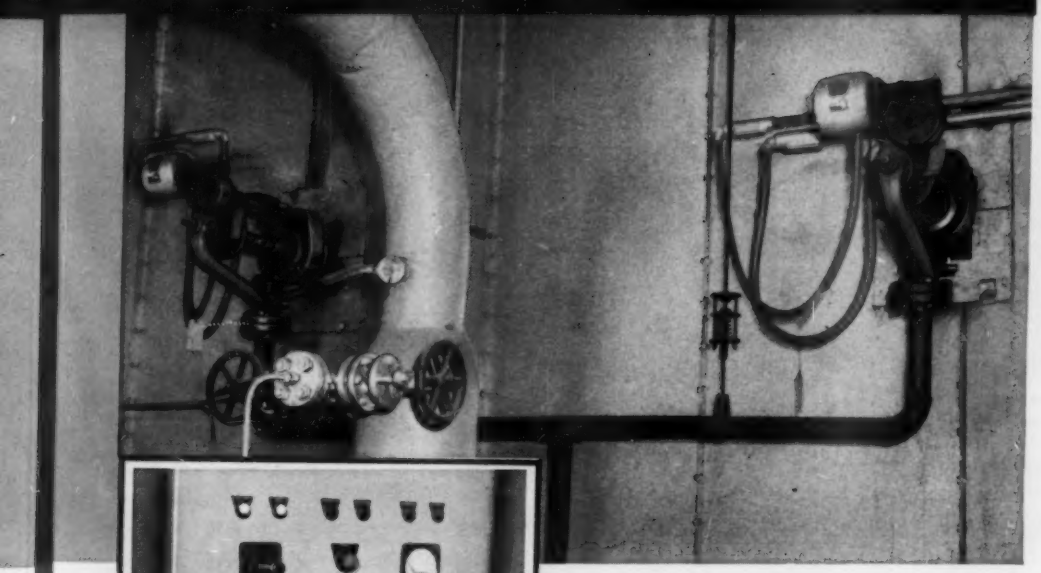
This is one of many examples of the savings possible by improvements now available in Diamond Blowers and Automatic Sequential Control. Over the years Diamond has engaged in continuous aggressive research in boiler cleaning. This research has paid off in improvements that save you money and improve your operation.

Let us make a study of your boiler cleaning . . . perhaps similar savings can be suggested.

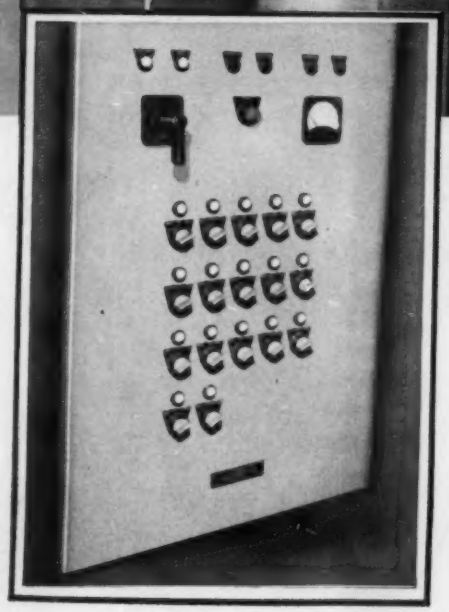
Per Year in Operation

and Cut Blower Maintenance Costs

SEQUENTIAL CONTROL PANEL



Two of the air blowing Model IR short retracting wall blowers with electric automatic operation.



Diamond Automatic Sequential Control Panel installed as part of the modernization program at the F. M. Tait Station. This panel automatically operates each blower in turn until the blowing cycle is complete. Any individual blower may be operated independently by simple turning switches. Cleaning program is set up by switches. Operator starts — thenceforth operation is automatic.

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

6243

DIAMOND SPECIALTY LIMITED • WINDSOR, ONTARIO

For more data circle 511 on Post Card

Gas Tempering: **Report No. 1**

Electric Utilities Find Safe Superheater

Metal Temperatures Across Width of Superheaters of Typical B&W Boilers with Gas Tempering

BOILER No. 1

Average Metal Temperature	1040 F	
Deviation		±40F

BOILER No. 2

Average Metal Temperature	1035 F	
Deviation		±50F

BOILER No. 3

Average Metal Temperature	1125 F	
Deviation		±45F

Gas Tempering Assures Tube Temperatures

Longer Tube Life
Less Superheater Maintenance
Need For High Alloys Minimized

The ideal gas temperature to which superheater tubes should be exposed is the lowest temperature that will provide the required superheat and reheat with a reasonable amount of surface. If this temperature is exceeded in order to make a larger proportion of the total heat released in the furnace available for superheating and reheating, alloy requirements are increased and there is greater danger of superheater tube failure.

Now, the required heat can be delivered to the superheater *without exceeding desired metal temperatures* by the use of Gas Tempering.

Gas Tempering—is the reintroduction of cool flue gases near the furnace outlet to control the temperature of the furnace gases entering the superheater. It allows you to control furnace exit gas temperatures under all operating conditions.

Definitive Booklet: If you'd like to learn more about the economies and design flexibility available to you through Gas Tempering, write for Bulletin G-96. Address: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Major Advantages of B&W Gas Tempering

. . . It cuts overall plant costs because the smaller size unit requires a smaller building per kw, a lighter foundation, less structural steel and shorter steam leads.

. . . It enables you to utilize the most economical available fuels. It permits the burning of a variety of coals without slagging, minimizes external corrosion of superheater tubes, and assures safe metal temperature, thus prolonging tube life, regardless of the fuel fired.

. . . It provides safe superheater tube temperature by positive gas temperature control; it protects superheater during startup and under all operating conditions.

. . . It makes it safer to design for economies offered by operation at steam temperatures of 1050 F and above.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

G-936

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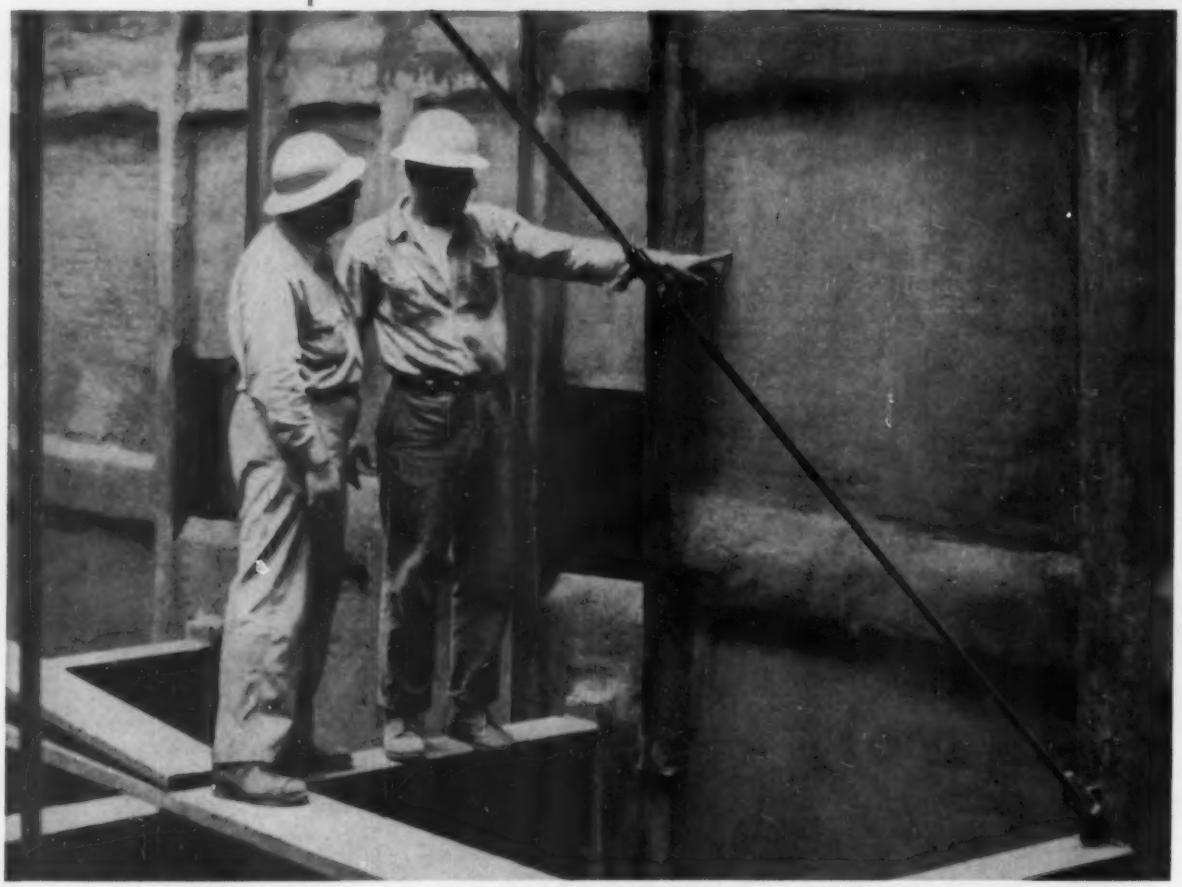
Con Edison
cuts corrosion

Lines its new precipitator with corrosion-resistant concrete made with Atlas Lumnite Cement



Consolidated Edison's Astoria Station, New York • Contractor: Research-Cottrell, Inc., Bound Brook, N. J. • Gunite Contractor: J. A. McCollum, Inc., Marlton, N. J.

To withstand the corrosive effects of fly ash and gases that will soon be punishing this new precipitator, a corrosion-resistant concrete lining made with Lumnite cement was installed. Industrial concretes made with Lumnite calcium-aluminate cement and suitable aggregates resist heat, thermal shock and abrasion, as well as corrosion. Poured, plastered or gunited, such concrete linings place easily (reaching full service strength within 24 hours) and provide good insulation. For convenience, manufacturers of refractories offer castables made with Lumnite cement, packaged mixtures ready for use with just the addition of water. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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Division of
United States Steel

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Hall Industrial Water Report

VOLUME 7 AUGUST 1959 NUMBER 4

More International Trouble

Industrial water problems know no geographical boundaries. They are as prevalent and troublesome in Europe and Asia as they are in North or South America. And, no matter where they arise, they require expert handling. This is why calls for Hall Laboratories services come from all over the world. Hall engineers are able to solve some of the problems by correspondence, but travel halfway around the world to tackle others on the spot.

The problems themselves are no different because they occur in Saudi Arabia or Chile. Each offers its unique combination of factors, and the Hall engineer uses his training and experience to decide what is significant and what practical steps must be taken.

Power for India

Water conditioning for a 150-megawatt power station in India was started more than five years ago and successfully controlled entirely through correspondence.

When the high-pressure unit was ready for operation, Hall engineers had already set up a complete program of water and steam conditioning to avoid water-connected trouble in any part of the station. They established the chemical conditions to be maintained in water throughout the plant. They specified the analytical procedures and equipment required for control, the necessary conditioning chemicals and how to feed them. They outlined in detail the mechanics of operating the clarifying and zeolite softening equipment for treating evaporator feedwater.

The operators carried out the program to the letter. Progress was followed through water conditioning reports and analysis of water samples submitted on a fixed schedule.

One problem did occur. Scale composed of mica and iron oxide was found in several water wall tubes of one boiler the first time it was inspected. Investigation revealed that the mica came from mud which got into the tubes before they were installed. Furthermore, these tubes had been damaged in transit; repair by welding and heating with blow lamps produced some iron oxide.

The general superintendent of the plant wrote to Hall Laboratories, "I wish to take this opportunity to thank you for the valuable help you have rendered us during the initial operation of this power station."

Costly Boiler Outages

Deposits caused numerous annoying and costly tube failures in the 625-psig boilers generating steam for power and process at an oil company installation in Arabia. Analysis showed the deposits to be composed principally of iron oxide but to contain significant amounts of magnesium phosphate.

Hall engineer A. M. Henricks made a complete survey of the plant. He established the source of the iron oxide to be corrosion in the condensate system. He recommended the use of a filming amine (Hagafilm®). This effectively reduced accumulation of iron oxide in the boilers. Test specimens showed a reduction in corrosion rate of about 90%.

The magnesium was traced to evaporator carryover. Changes in internal baffling and increased blowdown to hold evaporator water solids at a lower level effectively reduced the carryover.

Five years have passed. Boiler deposits are not a problem and tube failures no longer occur.

Superheater Tube Corrosion

Operators of a utility plant in Jamaica were surprised to find active pitting in the inlet and outlet superheater headers of a boiler which had been in service for several years. Their surprise was natural because recommended water conditions had been continuously maintained both when the boiler was operating and when it was idle.

The nature and location of the corrosion convinced the Hall engineer assigned to the job that the pitting had occurred when the boiler was idle. He discovered that when the boiler was prepared for wet standby, the water was properly treated but the superheater was not completely filled. This left the superheater headers full of moist air—an ideal condition for corrosion.

The headers were thoroughly cleaned and changes were made to insure complete filling during idle periods. After more than two years there has been no further attack.

Globe Trotters

Hall service is available through thirty-five local offices in the United States, Mexico and Canada. Consultation and service on water problems take Hall engineers to many other parts of the globe. Regular trips are made to Colombia, Venezuela, Haiti, Dominican Republic, Puerto Rico, Jamaica, Newfoundland and Cuba. Occasional visits are made to such faraway places as Saudi Arabia, England, Italy and Pakistan. And plants in some other countries like Chile, Argentina, Brazil, France and India have been successfully helped with their water problems by correspondence only.

Let us know if we can help you make water behave properly in your foreign installations.

Water is your industry's most important raw material. Use it wisely.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

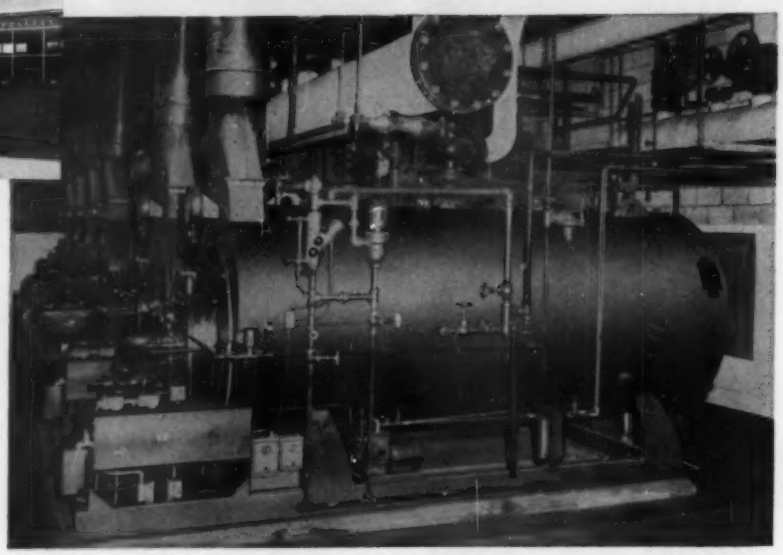
HALL LABORATORIES
DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.
In Canada: Hagan Corporation (Canada) Limited, Toronto

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

For more data circle 514 on Post Card

Never more steam than you can use . . .
never less steam than you should have!

One of the largest producers of graders, roadscrapers and rolling equipment, Galion Iron Works & Manufacturing Co., has six 125 HP Cyclotherms now operating, plans to add a seventh and eighth as steam demands increase. Automatic operation has been the big factor in helping Cyclotherm make the grade with the graders!



Like GALION ESTABLISHED 1907 Iron Works, plan for tomorrow with

CYCLOTHERM!

With Cyclotherm Steam and Hot Water Generators, you buy steam capacity as you use it. No investment in excess capacity. No steam shortage with an outgrown boiler.

Cyclotherms give flexible capacity. You can add 518 lbs. of steam per hr. with a 15 HP Cyclotherm, or 25,875 lbs. per hr. with a 750 HP Cyclotherm. And there are 16 intermediate sizes to choose from.

AUTOMATIC OPERATION

Cyclotherms operate with automatic efficiency. On 15 to 60 HP units, burner automatically shuts down when steam demands are satisfied, automatically turns on when more steam is needed. On 80 to 750 HP units, modulation controls regulate firing rate from 30% to 100% of rated capacity, without loss of efficiency. Operation stops automatically if firing sequence is interrupted and unit "fails safe."

BUILT TOGETHER TO WORK TOGETHER

Cyclotherm burner and boiler are built together to work together — one manufacturing responsibility back of the entire equipment. Units are fire-tested at factory, shipped ready to operate. Cyclotherms are up to 1/3 smaller than other package boilers of same capacity. Installation is easy—no costly stack, no excavation, no foundation.

"CYCLONIC COMBUSTION"

"Cyclonic Combustion"—Cyclotherm's patented combustion principle—guarantees a minimum of 80% efficiency, meets all state requirements, conforms to A.S.M.E. and National Board standards, carries Underwriters' Laboratories label. Steam Generators from 15 HP to 750 HP, burn oil and/or gas. Hot Water generators in 10 capacities, from 670, 000 BTU per hr. to 6,700,000 BTU per hr.

YEARS AHEAD IN STEAM & HOT WATER GENERATION

CYCLOTHERM®

STEAM AND HOT WATER GENERATORS

A Division of National-U. S. Radiator Corp. • 50 E. First St., Oswego, N. Y.

Clip to Your Letterhead

50

Please send me your booklet *Cyclotherm Cyclonic Combustion*, also rotogravure copy of *Cyclotherm Sales Steam* with illustrations and descriptions of Cyclotherm installations.

For more data circle 515 on Post Card

HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Recorders, Controllers — Bulletin GEA-6887, 12 pp, describes continuous self-standardizing strip-chart recorders and recording controllers for measurement of electrical and process variables. Includes product photos, application data, typical control system schematics, specifications, dimensions. Employing electronic servo-operated measuring systems, the instruments are designed to record with accuracy while providing sufficient torque to operate control devices. General Electric Co.

102 Dynamic-Measuring Instruments — Featured in 16-pp Bulletin 1310 is a line of dynamic-measuring and recording instruments, including oscillographs, data amplifiers and bridge balances; vibration measuring equipment; and power supplies. Recording oscillograph specifications and galvanometer specifications are included. Electro Mechanical Instrument Div., Consolidated Electrodynamics Corp.

103 Packaged Control Systems — Described in 10-pp Bulletin 170 are packaged control systems for gas-engine-driven compressors. Typical installations are pictured and various models are described as to features and instrumentation. Clark Bros. Co.

104 Turbine-Type Flowmeter — Described in this 8-pp bulletin is a turbine-type flowmeter for bulk plants, pipelines, refineries, chemical, food processing and other industrial services. The Potter-Bowser Meter Div., Bowser, Inc.

PUMPS AND COMPRESSORS

105 Rotary Pumps — Described in this bulletin are company's Series A internal gear rotary pumps for transferring a variety of liquid types in low to medium viscosities. High- and low-speed models are available and pumps can be supplied in four constructions. Bulletin provides performance data and dimensions, drive assemblies available. The Wayne Pump Co.

106 Gear Pumps — Bulletin G-1 describes gear pumps designed for a variety of difficult pumping applications. Cutaway view illustrates construction and operation details and tables give dimensional data. Schutte and Koerting Co.

107 Condensation Pumps — Four types of vacuum return line condensation pumps for heating systems are described in 12-pp Catalog J-200. Horizontal and vertical models with standard and special capacities are described. Catalog contains typical specifications, dimensions, installation diagrams and cutaway three-dimensional drawings illustrating operating characteristics. C. H. Wheeler Mfg. Co.

108 For Steam Heating — Catalog K-200 describes condensation pumps for steam heating systems. Features of the flexibly-coupled and close-coupled models are listed, and installation diagrams, ratings, capacities, and pressure speeds given. C. H. Wheeler Mfg. Co.

109 Turbine Pump Motors — Featured in 8-pp Form F-1975 is a vertical pump motor designed for short-coupled pumping service. Cutaway views showing component details are included, and advantages of design and operation are discussed. U.S. Electrical Motors Inc.

110 Heavy-Duty Compressors — Twelve-pp Bulletin A-73 covers heavy-duty industrial air compressors, providing specifications and dimensions for six basic models from 350 to 1250 hp, 2418 to 7392 cfm. Semi-radial design features are shown in a large cross-section drawing. Installation photos point up compactness of the rugged compressor. Joy Mfg. Co.

111 Packaged Compressors — Bulletin 158, 28 pp, presents advanced design and operating features of company's Model CFA packaged field compressors. Specifications are provided for complete line of two- and four-compressor models built in 15 sizes, 100 to 350 bhp. Clark Bros. Co.

PACKINGS AND SEALS

112 Hydraulic Packings — Sixteen pp of engineering data are contained in Bulletin P-333, which describes homogeneous and fabric reinforced hydraulic packings. Information includes design, construction, sizes, applications, installation, as well as illustrations, engineering drawings and tables. Crane Packing Co.

113 Handbook on Seals — Bulletin BF200-3 is a comprehensive 20-pp manual on use of company's long stroke, deep convolution constant area seals, and includes engineering data, design relationships, etc. Presents basic description of the seal along with typical applications, typical installation drawings, methods of attachment, installation techniques, standard dimensions. Besides analyzing four basic classes of seals, booklet tabulates construction materials of standard elastomer compounds as well as fabrics. Tables show tolerances for all classes of the seals. Bellofram Corp.

VALVES, PIPING, FITTINGS

114 Butterfly Valves — Bulletin 583 includes a table listing allowable pressure drop for company's metal-seated wafer butterfly valves. Construction features, methods of control are described and dimensional diagrams are included. W. S. Rockwell Co.

115 Diaphragm Control Valve — Eight-pp Bulletin J-170 describes sliding gate diaphragm control valves designed for accurate control of pressure-temperature liquid level. Includes engineering data, cutaway drawings, application information, dimensional drawings, rating charts, flow curve and sample specifications. OPW-Jordan.

116 Jacketed Valves — Bulletin 3 describes Aloyco 150- and 300-lb fully jacketed stainless steel valves designed for fluids difficult to move at room temperatures. Sectional views show gate, globe and check valve designs illustrating extensive jacketing which includes bonnet areas. Teflon disc designs and flanged fittings are described. Alloy Steel Products Co., Inc.

117 Steam Specialties — Twelve-pp Bulletin 203 discusses and illustrates valves, thermostatic traps, float and thermostatic traps, steam traps (250 psig maximum pressure as well as blast and high pressure) and pipeline strainers. Dimensions, capacities, patterns, weights and accessories are highlighted. Outstanding features of the valves, floats and traps, their construction and operation, are explained. American Air Filter Co., Inc.

118 Steel Water Pipe — Form P. O. 8859, on welded steel water pipe, treats such subjects as wide range of diameters and wall thicknesses, durability, high flow capacity, high strength and field fabrication. Includes information on standard and special fittings, joints. Armco Drainage & Metal Products.

119 Piping Products — Use of this company's couplings, fittings and other piping products is described in 8-pp Form 259. Contains product information, installation instructions, specifications, illustrations of such applications as fuel and supply lines, materials handling piping, equipment piping, pump settings, furnace lines. Dresser Mfg. Div., Dresser Industries, Inc.

120 Stainless Steel Fittings — Light-wall stainless steel fittings and flanges for non-critical process piping are described in this 6-pp bulletin. Illustrations show different methods of joining light-wall fittings and pipe, including a sequence of photos on "rolled in" flanged assemblies. Tube Turns, Div. Chemetron Corp.

121 Expansion Joints — Bulletin 59–50, 74-pp, features a line of packless joints for the control of all types of pipe movement. Design features and advantages are fully illustrated and described, and engineering and installation data, tables of forces, movements, and dimensions are included. Adsco Div., Yuba Consolidated Industries, Inc.

DUST CONTROL

122 Dust, Fume Control — Sixty plant installations are illustrated and described in this 52-pp catalog on dust and fume control systems. Sections are devoted to systems for the ceramic, foundry, grain, metalworking, steel and woodworking industries, and as many types of dust and fume control are featured as possible. Special sections detail centrifugal collects and unit collectors. Also covered are manufacturer's research and development facilities. The Kirk & Blum Mfg. Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 115 and 116.

123 Electronic Air Cleaner — Sixteen-pp Bulletin 249-A describes the Model B Rollotron, giving details of operation and electronic principle, and explanation of agglomerator and storage sections, capacity and dimension table, specifications.

Typical installations are listed. Explains operating simplicity of the unit and why it requires little maintenance. American Air Filter Co., Inc.

124 Dust Collector — Eight-pp Bulletin 291A describes characteristics and operation of a dry centrifugal dust collector designed to handle large exhaust volumes of granular dust. Cutaway diagrams and schematic drawings illustrate details and dimensions. American Filter Co., Inc.

MECHANICAL POWER TRANSMISSIONS

125 Power Transmission Digest — Eight-pp Bulletin A-706 presents a brief but comprehensive review of manufacturer's line of power transmission machinery. Featuring Flexidyne dry fluid drives and Para-flex flexible cushion couplings, bulletin also shows such Taper-Lock products as steel conveyor pulleys, roller chain drives, shaft couplings and Dyna-V belt drives. Among other products included are pillow blocks, bearing units, Torque-Arm speed reducers and screw conveyor drives. Dodge Mfg. Corp.

126 Roller Bearings — Condensed Catalog 59A contains 34 pp of detailed information on company's line of self-aligning roller bearings. Designed to aid in proper selection of bearing equipment for greater speed, higher load capacities and longer life, catalog includes data on roller bearing design, specifications, lubrication, seals and installation. Chain Belt Co.

127 Roller Bearings — Features and applications of company's line of roller bearings are detailed in 16-pp Catalog PL-559. Bearing specifications, general features, size availability and application data are included. Rollway Bearing Co.

128 Dry Bearing Materials — Bulletin DU-458A includes information on dry bushings and thrust washers, and installation tolerances and instructions for fitting bushings. Contains list of thrust washers currently available, including dimensions. United States Gasket Co.

129 For Flow Control — Eight-pp Bulletin A519 describes application of Gyrol fluid drives to pipeline pumping stations for pipeline flow control. Outlines advantages of the adjustable speed units. Operating principles are explained and illustrated with schematic section drawing of a typical unit. Curves chart economy of this drive vs constant speed drive with throttling control of flow. Line characteristics and pump characteristic brake horsepower and pressure curves provided. Industrial Div., American-Standard.

130 Sprockets, Roller Chains — Comprehensive 88-pp Catalog 60 features complete engineering data on company's sprockets and chain drives. Profusely illustrated with photos and dimensional diagrams, catalog covers various types of sprockets and roller chains and includes detailed data tables. Cullman Wheel Co.

131 Chain Drive Lubrication — Principles of lubrication, maintenance, and oil selection for roller and silent chain drives are covered in this product bulletin. Oil selection charts included. Sun Oil Co.

WATER TREATING

132 For Water Treating — Bulletin 615, 24 pp, describes recent developments in manual and automatic zeolite water softeners, demineralizers and deionizers, dealkalizers, ion exchangers, filters, purifiers, aerators and degasitors. Also covers spray and tray type deaerating heaters and water treating chemicals. Generously illustrated, explains basic operating principles of each type of equipment. Elgin Softener Corp.

133 Water Treatment Trends — Water conditioning trends in the paper industry, which is using increasingly more high pressure boilers requiring extremely pure feed water, are discussed in 8-pp Publication 120. How three major pulp and paper mills solved their boiler feed problems in different ways is explained. Cochrane Corp.

134 Feed Water Control — Advantages, principle of operation, and typical diagrammatic drawings of company's three-element feed water control systems are presented in 8-pp Bulletin 530. Installation photos are presented along with chart reproductions showing constant drum level under varying load conditions. Bailey Meter Co.

135 Water Well Treatment — Bulletin 601 describes a chemical treatment for water wells, well screens, gravel walls and adjacent water bearing formations to rid components of silts, muds, mineral scale and all types of microscopic organisms. Layne & Bowler, Inc.

ELECTRICAL

136 Substation Transformers — Bulletin GEA-5452A, 8 pp, describes Powermaster substation transformers rated single-phase, 500 kva and below, 15 kv and below, for use in distribution and industrial substations. Shows exterior and interior features and tells how these transformers can increase kva capacity of mounting pads as well as reduce operating and maintenance costs. Weights and dimensions included. General Electric Co.

137 Space Saving Motors — Eight-pp Bulletin GEA-6927 describes manufacturer's Thinline motor, rated 1 to 5 hp in dripproof and totally enclosed constructions for such limited space applications as fans, blowers etc. Includes description of product features, chart of interchangeable flange dimensions. General Electric Co.

138 Metal-Clad Switchgear — Bulletin 2804-1A contains 22 pp of detailed information on company's line of metal-clad switchgear. Features and advantages are fully detailed, and technical descriptions, dimensional drawings, panel layouts included, and various types of indoor, outdoor and walk-in enclosures are pictured. I-T-E Circuit Breaker Co.

139 Hook-Operated Switches — Described in 12-pp Bulletin PSE8 is a line of hook-operated disconnect switches for outdoor applications. Design features are illustrated and dimensional and mounting details are outlined. Line Material Industries, McGraw-Edison Co.

140 Precision Switches — Catalog 359, 28 pp, contains information on Unimax-snap-acting precision switches, including new sealed switches for severe environments. General purposes, low-force, high-sensitivity, open-blade, metal-cased, AN and JAN, d-c and reset switches are covered, as well as integral and auxiliary actuator styles. Pictorial index shows where to find dimensional drawings, specification tables and electrical ratings for each switch listed. Data on bases, terminals, circuit arrangements etc. are also provided. Unimax Switch Div., The W. L. Maxson Corp.

141 For Underfloor Distribution — Design and application methods for an underfloor distribution system are detailed in this 8-pp bulletin. Features are illustrated and fittings shown. Conduflor Corp.

142 Electrical Connectors — In addition to providing an illustrated nomenclature of electrical connector terms, 12-pp Catalog B 73 lists electrical current ratings for cable, as based on wire gages and number of wires. It covers manufacturer's complete line of electrical connectors which includes oval push-pull, round push-pull, round push-latch, quick-lock, straight pin bigun, round push-lock, and change-out styles. Each is described and illustrated in terms of typical applications, contact arrangements, types of seals and receptacle mounts etc. Joy Mfg. Co.

Postage-free cards for ordering catalogs are on page 115. You may also use the cards to order literature mentioned in the ads.

143 Insulated Leads — Described in 8-pp Bulletin RCT 320 are PVC insulated leads for oil-filled transformers. Discusses particular insulation properties required for oil-immersed transformer leads (flexibility, oil resistance, heat stability) and compares these requirements with properties of Synthinol 901. Rome Cable Corp.

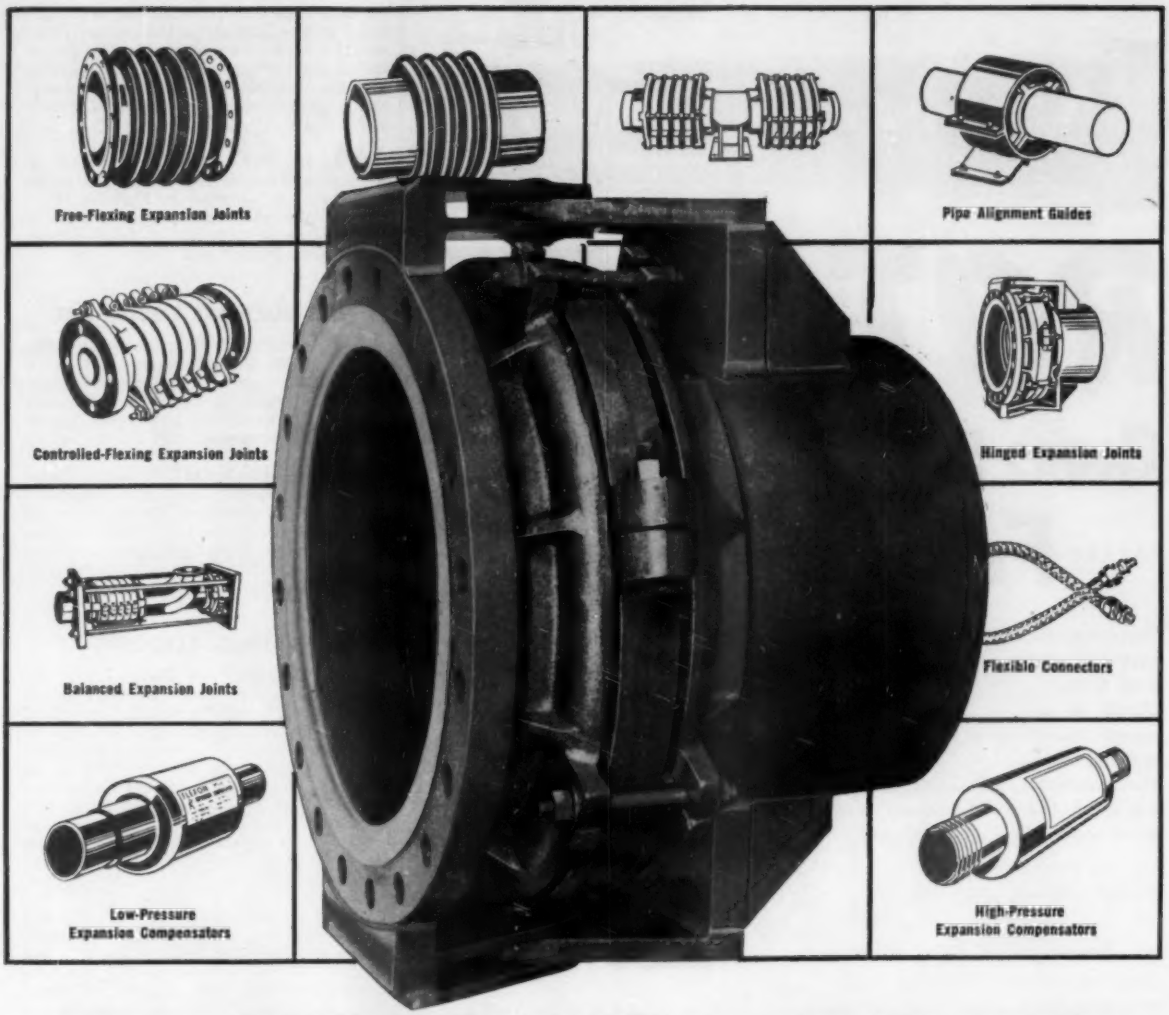
144 Improved Rheostats — Bulletin 41 contains 12 pp of detailed information on features and advantages of Jagabi Lubri-tact and carbon pile rheostats. A section tells how to select rheostats on basis of amount of pressure needed and temperature rise. James G. Biddle Co.

145 Dielectric Test Set — Bulletin 22-5 describes an instrument in bench and portable models for making step-voltage-current (or resistance) tests, voltage withstand and breakdown tests on the insulation of electrical equipment with ratings of 300, 600, 2500 v and higher. Specifications and prices are included, also outline of design and operating features of the instrument. James G. Biddle Co.

146 Storage Batteries — Facts about storage batteries are presented in this 32-pp booklet. Describes electrical system, battery chemistry and battery construction, and includes tips on battery care, maintenance. Exide Automotive Div., The Electric Storage Battery Co.

147 For Electrical Insulation — Booklet E-PCLC, on electrical insulation tapes, is a 32-pp guide and catalog with application information and specifications for electrical insulations. Product information, data for choosing electrical tapes, temperature limitation chart, guide for thermosetting tapes, test methods and outline of research and quality control are provided. Tapes with acetate, cotton, glass cloth, paper and plastic backings, resin tapes and resins are covered. Minnesota Mining and Mfg. Co.

148 Polyethylene as Insulation — Bulletin RCT 710 is a 10-pp technical paper



THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

For hinged or any other type of standard or special expansion joints – your best bet is FLEXONICS. Here's where you'll find the equipment, the experience, the skill to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from five FLEXONICS warehouses. They all add up to expansion joints that you can *install and forget* – plus expansion compensators, flexible connectors, the all-new FLEXONICS pipe alignment guides and other piping accessories.

Today—write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

Member Expansion Joint Manufacturers Association

EJ-240

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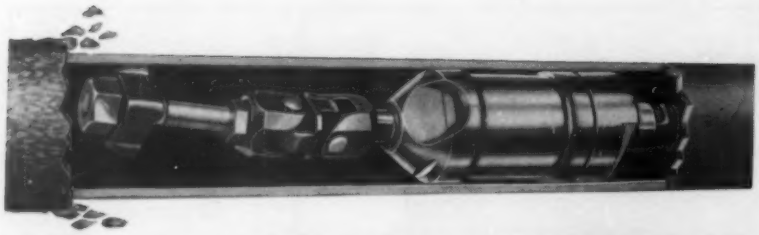


ROTOJET®

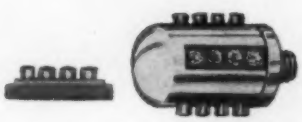
Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸ INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

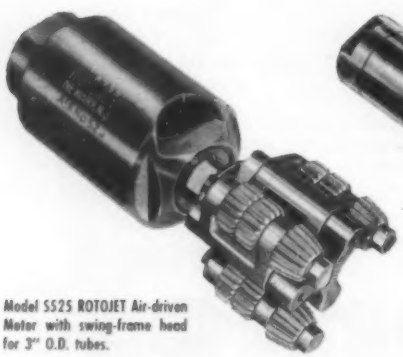
Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model S525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model S505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

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on flame retardant polyethylene as insulation for wire and cable. Generously illustrated with tables and charts, this paper includes a bibliography and an appendix giving specifications for black flame retardant polyethylene jacket insulation. Rome Cable Corp.

149 On D-C Failures — Effects of d-c tests and nature of d-c failures in cable insulation are covered in Bulletin RCT 712. A table showing leakage at a given test voltage as compared to years service is included. Rome Cable Corp.

FUEL BURNING EQUIPMENT

150 Packaged Burner — Bulletin FC-57, 12 pp, illustrates and describes a packaged burner for oil or gas, or combination firing. Features and performance advantages are explained, and typical installations are pictured. Coen Co.

151 Double Retort Stoker — Catalog 401 contains 8 pp of data on company's double retort underfeed stoker for heavy duty service. Construction details are illustrated with cutaway views and drawings, and typical installations are pictured. Detroit Stoker Co.

HEATING, COOLING

152 Heating Coil Data — Two do-it-yourself work sheets relate to use of company's Thermo-Panel coil. Data Sheet No. 58 presents fitting arrangements for single embossed panel — a total of 40 variations. Data Sheet 59 gives fitting arrangements for double embossed panels — 22 variations. Sheets contain drawings and dimensions for elbows, couplings, fittings. Inlet and outlet sizes are given, also fitting lengths. Dean Thermo-Panel Coil Div., Dean Products, Inc.

153 Heat Exchangers — Design and cost comparison data on heat exchangers using company's integral low-finned tubing is presented in this 20-pp catalog. Explains where the finned tube should be used, how fins affect design of heat exchangers and fouling factors, and includes conversion charts for various alloys. Wolverine Tube, Div. Calumet & Hecla, Inc.

154 Liquid Cooler — Bulletin 104R features a liquid cooler for accurate control of chilled water or solutions. Advantages are fully detailed and diagrams showing design and construction features are included. Niagara Blower Co.

OTHER EQUIPMENT

155 Tube Cleaners, Expanders — Eight-pp Catalog R53C describes a line of tube cleaners, tube expanders and portable pneumatic tools. Features and advantages are fully illustrated and described, and specification data included. Thomas C. Wilson, Inc.

156 Air Starting Motor — Case histories on air starting motor installations are presented in 24-pp Form 5094-E. Includes selection data, detailed specifications and mounting-dimension diagrams, piping arrangements. Ingersoll-Rand Co.

157 Flame Ceramics — Described in this illustrated brochure is the flame ceramic process for protecting metals against temperatures up to 5500 F. Describes the flame ceramic process, the flame ceramic torch, the flame ceramic powder feeder

YOU never saw a metering pump like this!

NEW streamlined safety shield. NEW crank-type design. NEW improved accuracy. NEW parts interchangeability. NEW operational efficiency. NEW maintenance ease . . .

all at a new lower price!

Meet Hills-McCanna Masterline . . . four metering pump models developed to bring increased economy and accuracy to metering and proportioning! Tested and proved capable of registering new highs in performance and dependability. Hills-McCanna Masterline pumps handle payloads from a fraction of a gallon to 1030 gph per feed . . . and are designed all new *inside* and *out* to do it better than ever. For new maintenance ease and the best pump investment, investigate Masterline pumps *now* for your chemical proportioning, water treatment, petroleum addition and other similar needs!

Write for informative new booklet! Just published, this new booklet gives all the details on Hills-McCanna Masterline Metering Pumps . . . pinpoints the features and elements that make Masterline pumps tops—for now and the future. Ask for Bulletin #900 "Look What's New in Metering Pumps." *Hills-McCanna Co., 4600 W. Touhy Avenue, Chicago 46, Illinois.*

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW

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ELLIOTT
Twin Strainers
for
Dependable
Continuous
Service
WHILE THIS ONE IS BEING CLEANED
THIS TWIN IS IN SERVICE . . .
While flow goes through this compartment
This one is closed for cleaning. Back-flushing water enters at side, drains at bottom.

Twin Strainer with special back-flushing feature

Elliott Twin Strainers are built in two types. With Type A, one strainer basket is removed and dumped, while liquid flows through the other basket. Type A strainers are also built with a back-flushing feature, whereby the closed-off compartment is cleaned by reversing the liquid flow. Flushing and draining connections permit liquid to enter side of compartment, flow through basket and drain at bottom. Type V, with large-size baskets, is designed primarily for handling oil and viscous liquids.

For over 50 years, Elliott Strainers have been effectively removing objectionable solids from water and other liquids. The resulting trouble-free service has led to installations in power and industrial plants all over the country. Elliott also makes Single Strainers, one type having an Automatic Self-Cleaning feature, the other type with a removable basket for manual cleaning. For details call your Elliott District Office or write Elliott Company, Accessories Department, Jeannette, Pa.

A7-1

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

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and the flame ceramic powders. Continental Coatings Corp.

158 Tubing and Facilities — Form CF-3 is a 14-pp revision of company's tubing and facilities catalog. Describes carbon and alloy seamless steel tubing in mechanical, pressure and other grades. A foldout flow chart shows major steps in seamless steel tube production. Contents also cover electric welded carbon steel tubing in mechanical and pressure grades, forging and fabricating operations, special tubular shapes. Ohio Seamless Tube Div., Copperweld Steel Co.

. . . Outstanding Among This Month's Catalogs

159 On Refractory Cements — How to select the right refractory cement for the job is stressed in this 20-pp booklet on cements, mortars and coatings. Product descriptions cover metallurgical refractories, general purpose and special purpose types and coatings. Features, performance data and application suggestions are provided. Firebrick and many other special shapes are also covered. Mexico Refractories Co. Div. Kaiser Aluminum & Chemical Corp.

160 Grating and Treads — Safety, visibility, permanence and easy maintenance are among advantages of open flooring discussed in 28-pp Bulletin 2527-R. Covers use of electroforged grating in a wide range of industries; also features grating applications in sidewalks, locks and dams, sewage treatment plants. Information provided includes types and spacing, bearing bar surfaces and weights, fastening methods, and safe loads for electroforged carbon steel and aluminum interlock grating. Blaw-Knox Co.

161 Vibration, Noise Control — Eight-pp Booklet K4E gives engineering specifications and performance data for 27 types of products for control and measurement of machinery vibration, shock and noise. Installation photos show solutions to some typical problems. Discusses relative merits of steel springs and organic materials as isolation media. A selector chart covers a wide range of equipment, showing recommended and alternate isolation methods. The Korfund Co., Inc.

162 Oxygen Therapy — Equipment and techniques for use during industry's "most urgent emergency" — the interruption of a worker's breathing — are described in 12-pp Booklet NM-116. Illustrates complete line of resuscitation and inhalation therapy equipment. National Cylinder Gas Div., Chemetron Corp.

163 Fluorocarbon Resins — Electrical and electronic properties of fluorocarbon plastics are detailed in this 26-pp bulletin. Gives properties of the material, suggests design considerations in electrical and electronic systems, and reviews specific applicat ons in which these fluorocarbon resins solved a design problem. E. I. du Pont de Nemours & Co.

165 Surge Absorber — Bulletin SK-59 describes surge absorbers designed to

Specify POWELL PRESSURE SEAL GATE VALVES

In all sizes—600, 900, 1500, 2500 Pounds and Higher. Globe, Angle and Check valves also available.

Pressure Seal Gate Valves, made the superior Powell way, offer many advantages—including:

* Streamline flow passage—making possible maximum flow with minimum turbulence.
* Outstanding simplicity of design, smooth body contour and weight reduction—assuring easier installation, greatly reduced insulating costs, and a marked saving in space.

For all your flow control requirements—water, oil, gas, air, steam, and corrosive fluids—Powell has the right valve in the right size and the right metal. Consult your local Powell distributor or write directly to us.

THE WM. POWELL COMPANY
Dependable Valves since 1846
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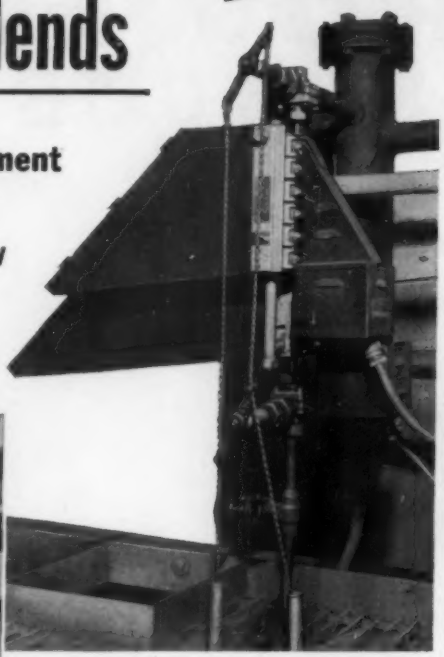
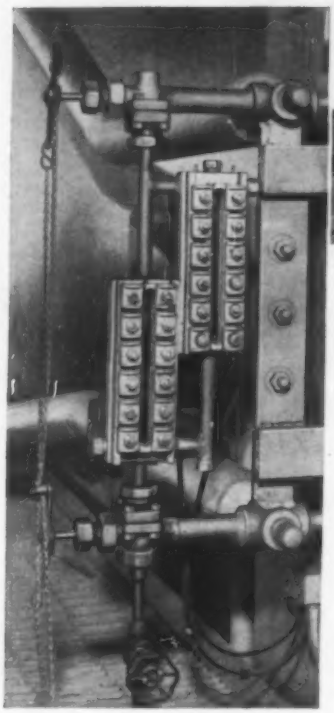
POWELL...world's largest family of valves

For more data circle 520 on Post Card

Boiler Water Level Security Pays Dividends

...Reliance Equipment insures safe, sure supervision for low or high pressure plants





"Two water gages on all boilers operating at over 400 psi" says the code. Here's an example, in the municipal light and power plant of Coffeyville, Kans., illustrating modern Reliance 900 psi equipment.

Water column includes whistle alarm; is equipped with flat glass gage insert, periscope hoods to reflect image through cat-walk opening to a floor-stand mirror below; and mercury lamp illuminator for sharp, brilliant projection. The second gage, also of double-window flat glass construction, is custom-made with tie-bar, for direct-to-drum installation.

Reliance builds for all pressures — brings you a complete line of boiler safety devices. The long record of efficient, dependable service — the extra margin of safety built into all Reliance Equipment — assures long life and low maintenance. Check with your consultants or ask for nearest Reliance Representative address.

The Reliance Gauge Column Company

5902 Carnegie Avenue • Cleveland 3, Ohio

BOILER SAFETY DEVICES

Reliance

1884 75th YEARS 1959

For more data circle 521 on Post Card

take shock and pulsation from pipelines. Advantages of design and operation are detailed, and tables of dimensions and specifications are included. Hydril Co.

166 Industrial Floors — Many types of industrial floor are studied and their soil removal problem analyzed in this 8-pp booklet, complete with charts, list of cleaning compounds, and descriptions of cleaning methods. Methods of sanitizing, stripping wax and paint, and of absorbing liquids are also discussed. Oakite Products, Inc.

167 Welding Small Pipe — Two technical articles on small pipe welding — "Fabrication of Small Piping by Welding and Brazing," and "Designing for Welded Systems of Small Size Pipe," — are featured in 10-pp Bulletin Form ADR 118. Air Reduction Sales Co., Div. Air Reduction Co., Inc.

168 Wrought Iron — Mn wrought iron, a specialty alloy wrought iron containing approximately one per cent manganese, is described in this 8-pp booklet. Charts showing metal's impact resistance at sub-zero temperatures are included, as well as data on corrosion and other properties. A. M. Byers Co.

169 Corrosion Resistant Equipment — Characteristics and advantages of Corite — a structural material for corrosion resistant plant equipment — are detailed in this 8-pp bulletin. Physical properties, manufacturing and design data, and chemical resistance of the material are covered. Corite Products Inc.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

170 Reinforced Plastics — Described in 28-pp Catalog P-11 is a wide range of applications for polyester-glass industrial corrosion-resistant equipment. Covers physical properties, chemical resistance and typical equipment applications, and includes detailed specifications and selection data. Haveg Industries, Inc.

171 Sheet, Plate Fabrication — A variety of parts and assemblies — from massive boiler breechings to smallest stamping — are illustrated in 40-pp Bulletin F4. Facilities and equipment for production are illustrated, including shearing, contour cutting, punch press, large presses, brakes, welding, large and small structurals, assembly. The Kirk & Blum Mfg. Co.

172 Duct Fans — Bulletin A-114A, 12 pp, presents belt-drive fans, from 12 to 60 in., with adjustable driver sheaves which permit quick adjustment of fan speed. Also gives dimensions, performance data and construction details on direct-drive duct fans in the same size range, the Bi-Pass duct fan with the motor mounted in a tunnel out of the air stream, and a reversible duct fan which moves air in either direction. Hartzell Propeller Fan Co.

Beating the Schedule at Rocky Reach

Working right around the calendar, Stone & Webster engineers are keeping construction progress well ahead of schedule on the giant Rocky Reach Hydro-Electric Project on the Columbia River. Now close to the halfway mark, the mile-long dam and powerhouse for Chelan County Public Utility District, Washington will be completed by mid-year 1962 . . . to provide an initial 775,000 kw from 7 generating units for homes and industries in both Washington and Oregon. Later, 4 additional generating units will boost total station capacity to 1,200,000 kw.

Stone & Webster Engineering Corporation is prepared to undertake complete responsibility for the design and construction of projects of any magnitude...or to provide engineering services tailored to fit your own requirements. For more information call or write our nearest office.

STONE & WEBSTER ENGINEERING CORPORATION

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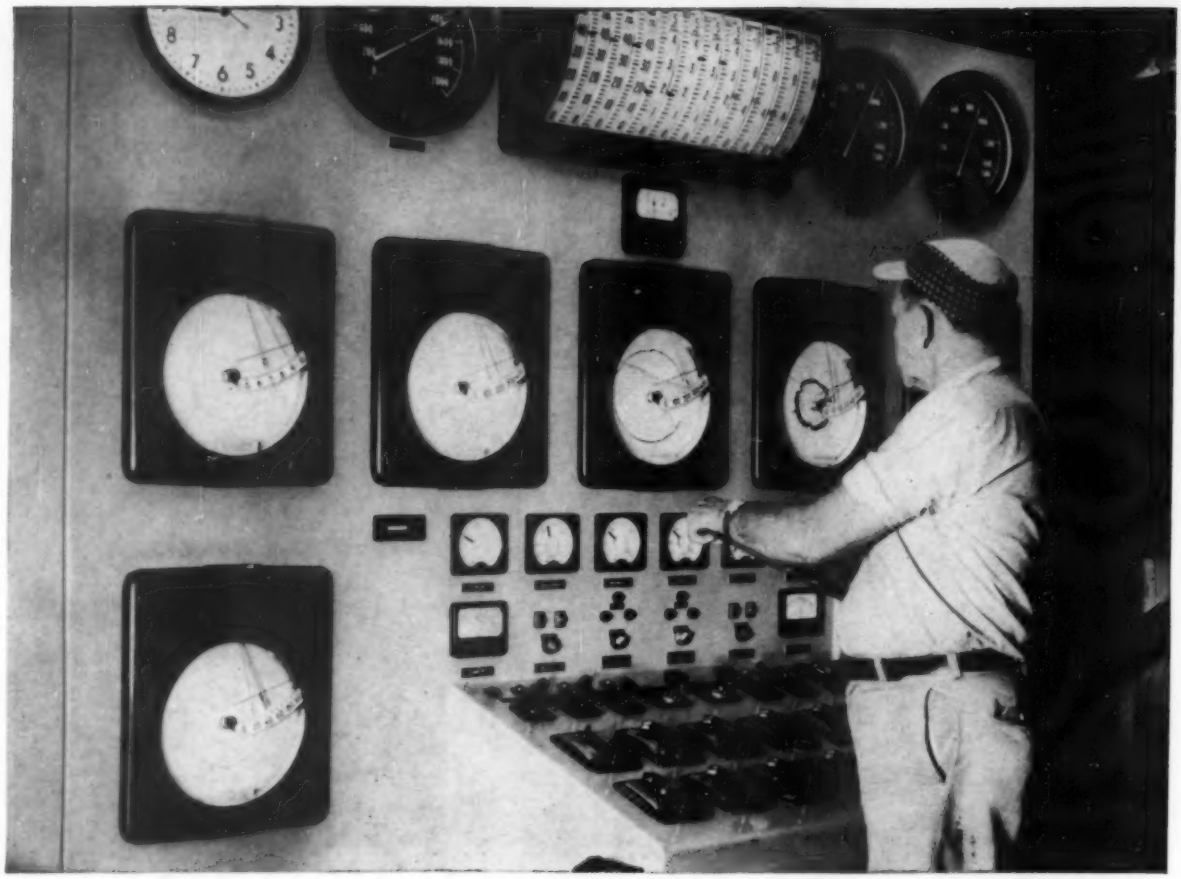

Control Room for Cyclone Furnace Boiler at Mathews No. 2 Power Plant of Greenwood Mills, Greenwood, S. C. Bailey MINI-LINE System concentrates controls at operator's station.

How BAILEY simplifies operation of STEAM PLANTS

Your operators can work more efficiently, make adjustments faster when you put Bailey Controls at their finger tips.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report.

Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs.

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment, that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant problems.

A138-1

Instruments and controls for power and process

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In Canada—Bailey Meter Company Limited, Montreal

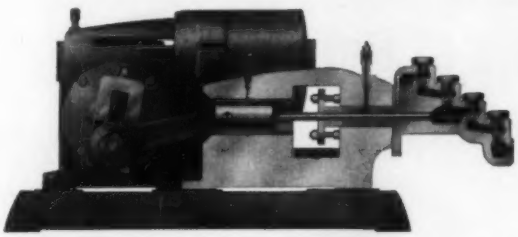
For more data circle 523 on Post Card

HOW TO METER SLURRIES ACCURATELY

Few pumping jobs present more complex problems than the accurate metering of slurries. Since they are often abrasive, slurries can make the selection of pump parts extremely difficult. Minute particles settling out in the packing can score a plunger beyond usefulness in minutes. And viscous, tacky slurries can limit ball check freedom and reduce accuracy. But even the toughest slurries *can* be metered accurately . . . by adhering to good slurry handling practice, and by choosing the right pump for the job.

Keep Slurries In Suspension

Several practices that have proved valuable in this difficult service are aimed at keeping the solids in suspension. Suction and discharge lines should be as short as possible. The supply tank should always be well agitated. And if packed plunger pumps are used, stroking speed should be held between 45 and 75 rpm to minimize settling.



Standard Motor Driven Controlled Volume Pump

Choosing The Right Pump

Controlled volume pumps are manufactured in a sufficient variety of designs to provide a full range of desired characteristics for slurry service. An economy pump such as Milton Roy's H20® can handle slurries up to 5% by weight. Standard motor driven pumps, with minor modification, can handle much denser slurries. And the new ODS (Oliver Diaphragm Slurry*) controlled volume pump can easily manage slurries containing up to 60% solids by weight.

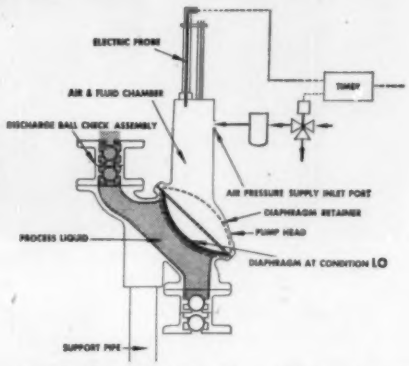
*Manufactured under exclusive license granted by Dorr-Oliver Inc.

Packed Plunger Pumps

Because the entire liquid end of a packed plunger pump is in intimate contact with the slurry, considerable attention must be paid to materials selection. Ball checks and plunger should be as hard as possible, and seats should be relatively soft. Balls are usually made of Hastelloy D, 440 stainless, or ceramic, while 316 stainless is standard for the seats. The plunger must be extremely hard, and high strength sintered alumina is generally recommended.

Proper packing maintenance in slurry service demands that packing be flushed out continuously. An internal flush, continuously bleeding a small amount of liquid along the plunger, is the most common. Dangerous liquids may require an external flush arrangement. Liquid is continuously fed in on one side of the lantern ring, drawn around the plunger, and carried away from the other side.

The ODS Controlled Volume Pump



Capable of pumping 180 gph of the densest slurries at accuracies of ± 2% against pressures up to 90 psi, the ODS has no plunger, no packing. It is based on the Oliver Diaphragm Slurry pump design principle which consists of two opposed chambers separated by a slack diaphragm. A three-way solenoid alternately pressurizes and bleeds air from the upper chamber. With the upper chamber at atmospheric pressure, the suction head forces slurry into the lower chamber. Then, when the upper chamber is pressurized, the diaphragm forces the slurry out through the specially designed ball check valves.

Problem Slurries

Yes, slurries *can* be metered accurately. And the best proof of this claim is the thousand or more Milton Roy pumps successfully metering slurries in the field. The list includes such problem liquids as an 80% coal slurry, a 45% suspension of lead peroxide in butyl phthalate, 15 to 20% diatomaceous earth slurries, finely divided nickel catalytic suspensions, gold ore slurries, and even a 55% by weight powdered aluminum suspension. Some of these materials are so thick that they can support the weight of a screwdriver.

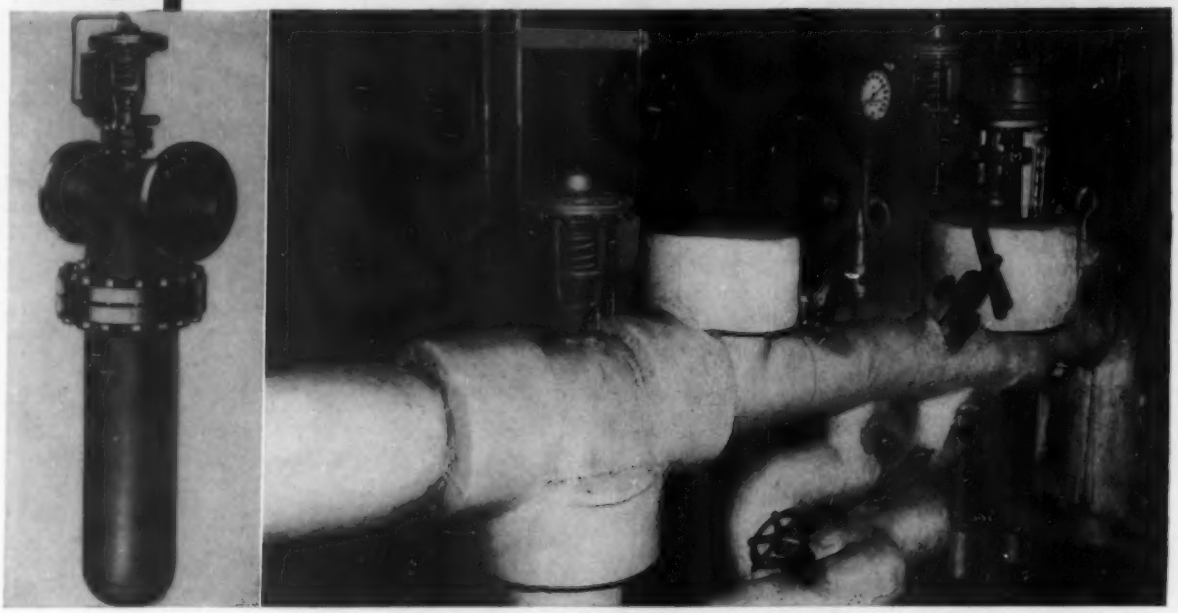
If precision metering of slurries is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solutions. Write for a general introduction to controlled volume pumping given in Catalog 553-1, Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers • Chemical Feed Systems

For more data circle 524 on Post Card

COPES VULCAN | BLAW-KNOX **How Copes-Vulcan control systems boost power plant efficiency**



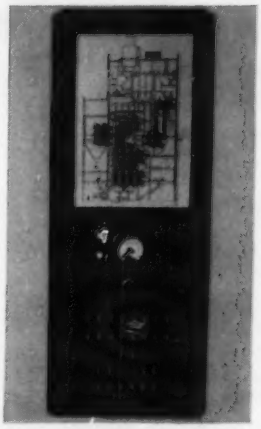
Carburetor-Type Desuperheater used at Barrett Station. Available in standard 2" through 12" sizes, in 150 through 600-pound pressure standards for cast steel. Larger sizes and higher pressure standards are available on special application. Final temperature may be held within plus-or-minus 5°F. Write for Bulletin 1056.

Copes-Vulcan reducing and desuperheating station takes load swings at Barrett Plant

Long Island Lighting Company uses a Copes-Vulcan desuperheating and pressure reducing station to handle seasonal demands for building heating at their Edward F. Barrett Station. Specifications require the station to condition flows of 500 to 25,000 pounds per hour, from 2015 psig and 1005°F. down to 165 psig and 385-400°F.

3,000 to 17,000 pounds per hour in 30 seconds. During evening hours in winter, the generating unit comes down to half load, or less, requiring the P-R-D station to feed pre-heater steam coils. When these coils are supplied from the P-R-D, the load swings from 3,000 to 17,000 pounds per hour in 30 seconds. The station, consisting of a Copes-Vulcan Carburetor-Type Desuperheater and a heavy-service piston-type valve, holds final (reduced) pressure and temperature constant.

Copes-Vulcan also offers two other types of desuperheater: a Steam-Assist (Bulletin 1024-A), and a Variable-Orifice type (Bulletin 1037).



Barrett Station controls soot blowing on Unit 1 with a Vulcan Automatic-Sequential System. For details, write for Bulletin 1029. (Panel shown gives automatic-sequential control for up to 60 soot blowers.)

Piston-type valves meet rigid requirements for unusually high operating force and accurate positioning. Copes-Vulcan also builds diaphragm-type CV-D Valves that have excellent rangeability. Write for Bulletin 1027.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

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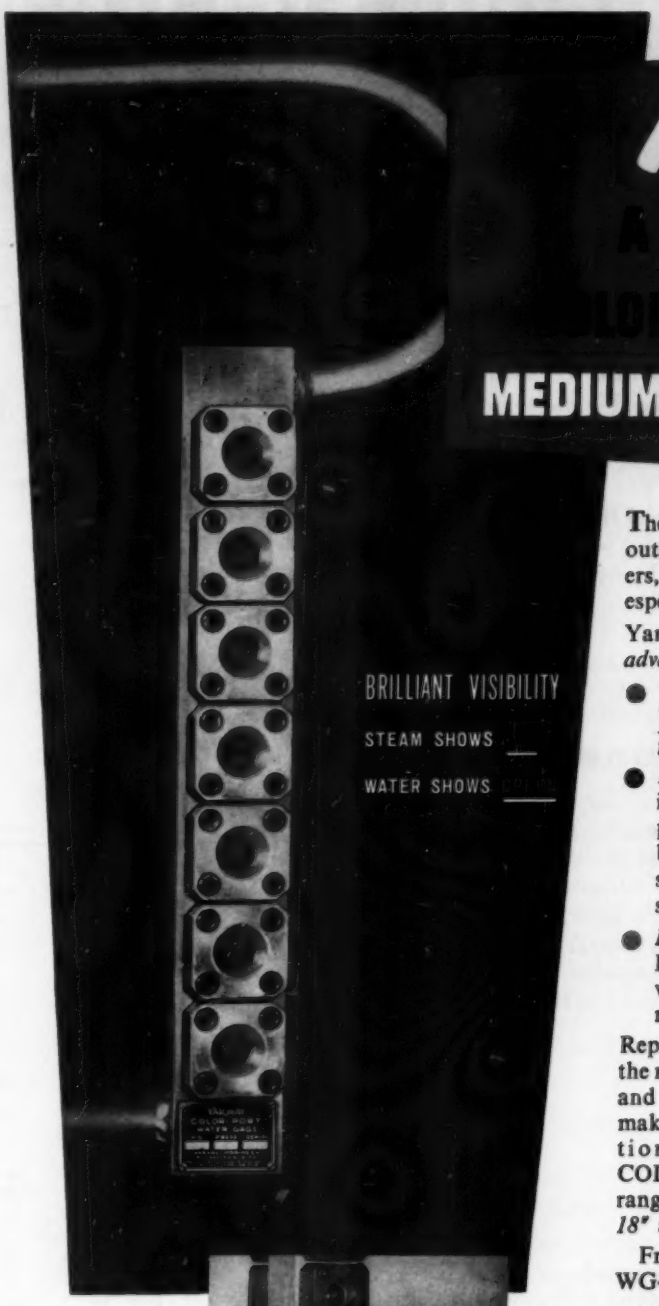
NEWS FROM YARWAY



now!

A NEW YARWAY COLOR-PORT GAGE FOR MEDIUM PRESSURE BOILERS

The Yarway Color-Port Water Level Gage, so outstandingly successful on high pressure boilers, is now available in a new model designed especially for boilers operating up to *1050 PSI.*

Yarway Color-Port gives you all these *triple advantages:*

- *Two color readings,* brilliant and clear. Water shows green; steam shows red. A full gage is all green; an empty gage all red.
- *Low maintenance.* Servicing the Color-Port is simple as A-B-C. With gage remaining in place, individual cover plate assemblies can be inserted in a matter of minutes. Exclusive spring loading maintains proper pressure on glasses and gaskets at all times.
- *Increased operational time.* Yarway Color-Port Gages assure longer operational life, with a minimum of "time out" for maintenance.

Replace troublesome water level gages with the new medium pressure Yarway Color-Port—and for your new boilers, make sure the specifications read YARWAY COLOR-PORT. Visibility ranges of *13"*, *15½"* and *18"* available.

Free descriptive Bulletin WG-1815 on request.

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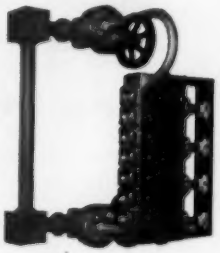
BRANCH OFFICES IN PRINCIPAL CITIES



Complete Color-Port assembly, with tie-bar column, Welbond Gage Valves and Yarway Illuminator.

Complete cover plate assemblies can be replaced in minutes, with the gage in place.

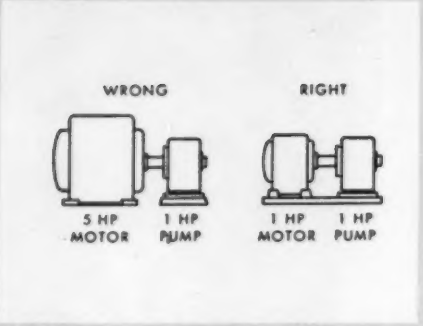
YARWAY®

For more data circle 526 on Post Card

Tips on evaluating Electrical

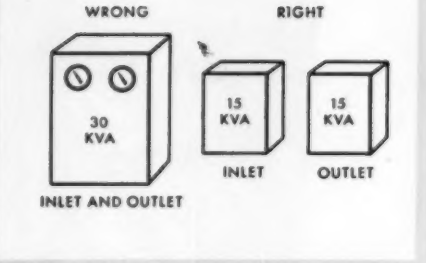
Matched Electrical Sets

You wouldn't use a 5 h.p. motor to run a pump that required only one h.p. Similarly, electrical sets should be *matched* to the requirements of the specific job. Electrical sets should be sized according to gas conditions, dust conditions, and other operating characteristics, and in accord with manufacturers' past experience on similar installations. *Don't be misled by high KVA ratings on the electrical sets.* The precipitator will only absorb a certain amount of power and the sets should be sized accordingly. A large excess of installed power, which will never be used, means inefficient use of the equipment.



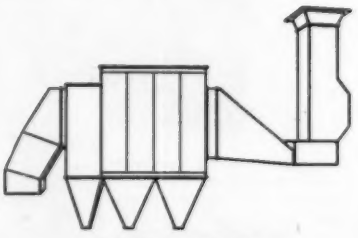
Varied Electrical Conditions

Electrical conditions in a precipitator can vary widely at different parts of the precipitator. For instance, a high voltage, low current condition usually prevails at the inlet where the dust load is high, as compared to a lower voltage higher current condition at the outlet. Consequently, it is good design (and a necessity for high efficiency) to furnish several electrical sections in series, with energization from separate electrical sets so that each section can be adjusted to best suit the conditions.



Gas Distribution

Remember that gas distribution, gas baffling, and provision against hopper sweeping all have a large influence on collection efficiency. The gas flow system should be analyzed as closely as possible, both in the precipitator and in the associated ductwork. If in doubt, have a three-dimensional gas flow study made. Two-dimensional gas flow studies *are not as accurate* and may lead to erroneous conclusions.



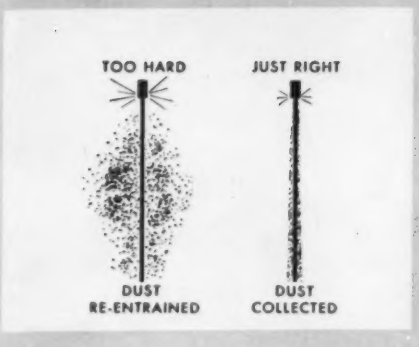
RESEARCH

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, New Jersey

RC 101

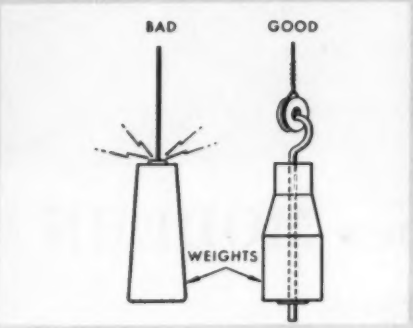
Precipitators

Some helpful hints to aid in selecting a properly designed unit



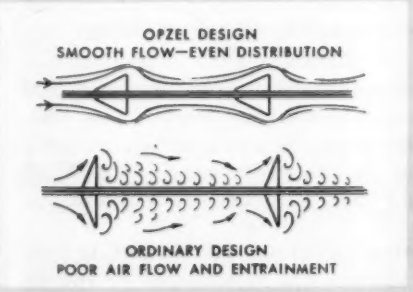
Rapping Intensity

Rappers should have easy means to vary the intensity of the blow to suit variations in operating conditions. A pre-set intensity setting cannot possibly give proper rapping over the normal range of operation. If too soft, build-up will occur which will disturb electrical conditions. If too hard, there will be reentrainment. Means of intensity adjustment are necessary to avoid drop-off of precipitator efficiency as conditions change.



Corona Discharge

It is a relatively easy matter to obtain a corona discharge in an electrostatic precipitator. Many types of discharge electrodes have been used over the past forty years, including ribbons, squares, twisted squares, star shaped sections, coiled wires, wires with prongs and projections, most of which give entirely adequate corona conditions. Final choice then gets down to mechanical factors such as strength of wire, method of support to avoid stress points, and ease of handling. There are many claims made for various types of wires but after investigating and testing hundreds of different kinds, we find a straight round wire about .1" diameter to be best.

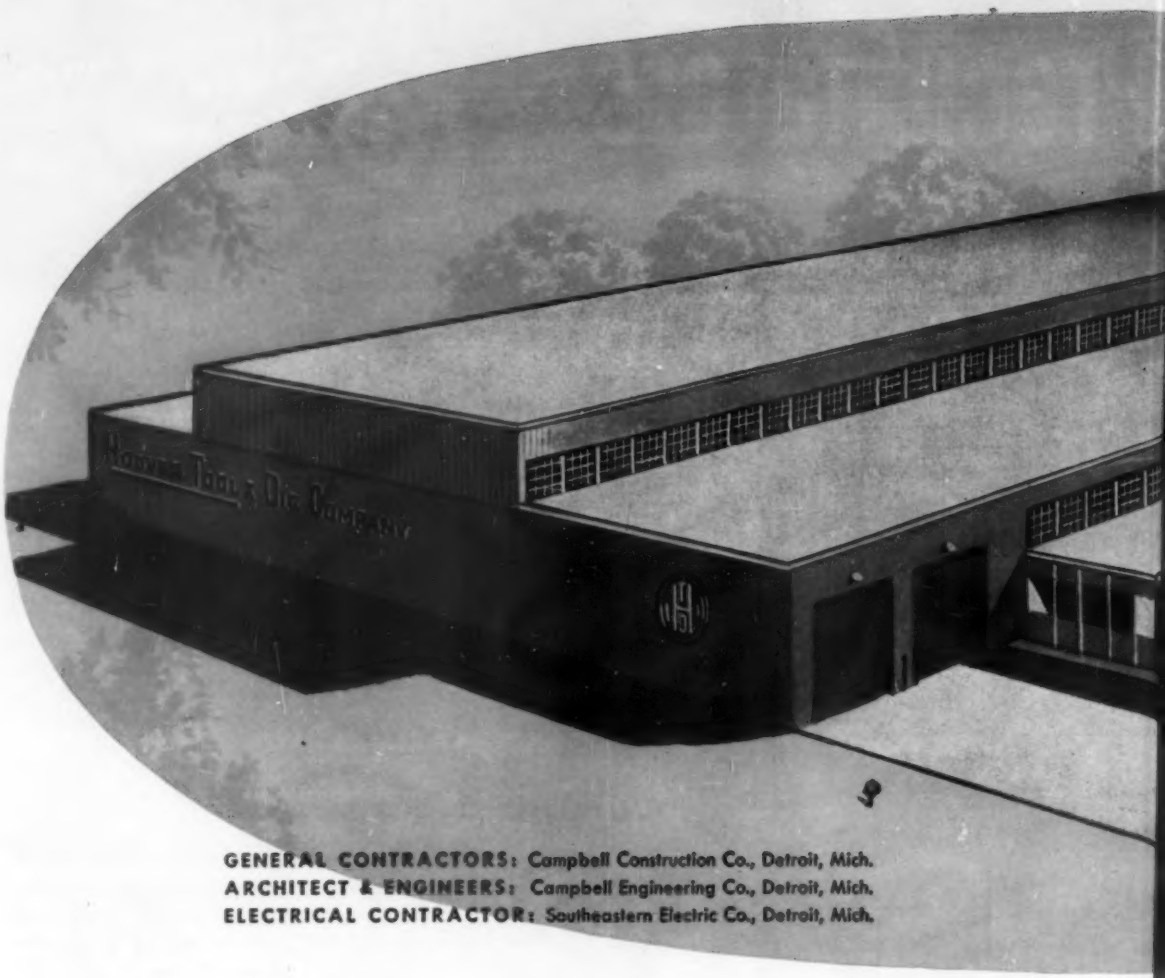


Baffle Design

Careful attention to the design of baffles on the collecting plates is most important. Small amounts of reentrainment mean tremendous differences in over-all collection efficiencies. It is seen that the "quality" of the collecting surface is far more important than quantity — quantity (sq. ft. of surface or treatment time) in itself is not a criterion of performance.

-COTTRELL

Representatives in all major cities of U.S. and Canada



GENERAL CONTRACTORS: Campbell Construction Co., Detroit, Mich.
ARCHITECT & ENGINEERS: Campbell Engineering Co., Detroit, Mich.
ELECTRICAL CONTRACTOR: Southeastern Electric Co., Detroit, Mich.

Electrical Protection goes MODERN *with* BUSS Fuses

in the Hoover Tool & Die Co., Centerline, Mich.

This new industrial plant on the outskirts of Detroit illustrates that the modern trend in electrical protection is to fuses. The main switch gear is a 1600 ampere pressure switch protected by BUSS Hi-Cap fuses. The distribution panels, both power and light, are equipped with FUSETRON dual-element fuses.

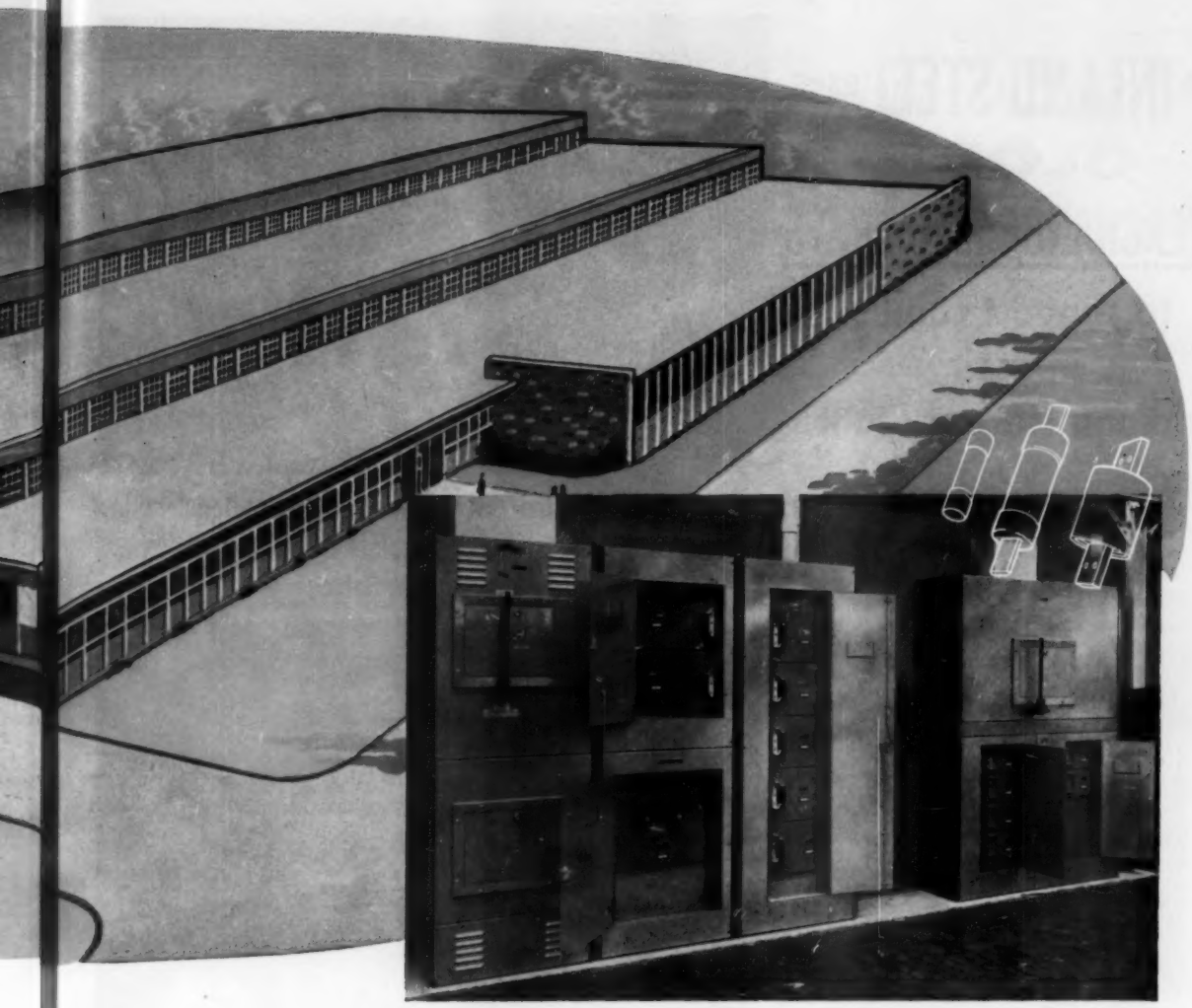
This plant will have many operating advantages because fuses are installed. *For instance:*

Future expansion without sacrificing safe protection.

Provisions were made to install a second 1600 ampere pressure switch when needed. This additional capacity and any increase in available fault current can safely be handled by BUSS Hi-Cap and FUSETRON dual-element fuses.

The interrupting rating of BUSS Hi-Cap fuses is 200,000 amperes rms symmetrical — and for FUSETRON fuses it is 100,000 rms symmetrical.

ANOTHER BUSS HI-CAP AND FUSETRON FUSE INSTALLATION



Main Power Panels —
BUSS Hi-Cap and FUSETRON Fuses

Through the year's savings result from the greater dependability of fuses.

Unlike mechanically operated devices, a fuse has no hinges, pivots or contacts to stick or get out of order. Dust, fumes, corrosion or age cannot increase a fuse's capacity or lengthen its blowing time.

After years of service, a fuse will give the same safe, dependable protection if called upon to open as it would have given on the day it was installed.

The dependability of BUSS Hi-Cap and FUSETRON fuses helps to reduce costs — by preventing damage and loss due to electrical faults — by being maintenance free — by requiring no periodic inspections — and by eliminating shutdowns caused by needless outages.

Is it any wonder then that "ELECTRICAL PROTECTION IS GOING MODERN WITH FUSES"? No other type of protective device can match the combined high-interrupting capacity, dependability and maintenance-free features of fuses.

For more information

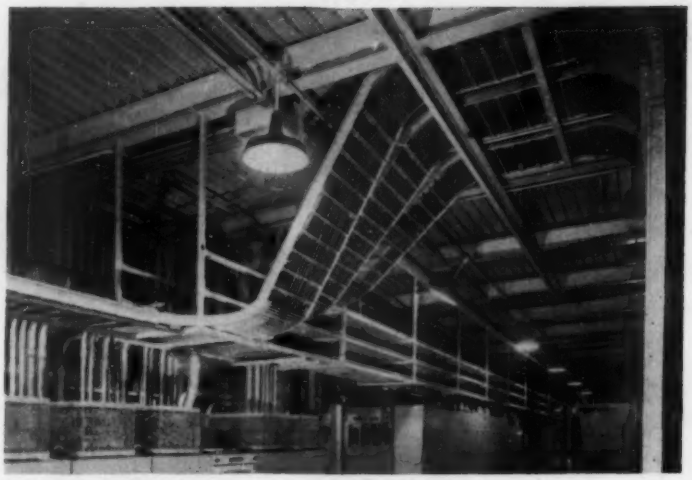
On BUSS Hi-Cap fuses . . . . *Write for bulletin HCS*

On FUSETRON dual-element fuses . . . . *Write for bulletin FIS*

BUSSMANN MFG. DIVISION, McGraw-Edison Co. ST. LOUIS 7, MO.

For more data circle 528 on Post Card

how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS to support cables in their Indiana Harbor Plant



★ Engineered for Uniform Design and Easy Installation ★ Steel or Aluminum Construction
★ Complete Accessories for SPEEDIER Installation ★ Complete Interchangeability
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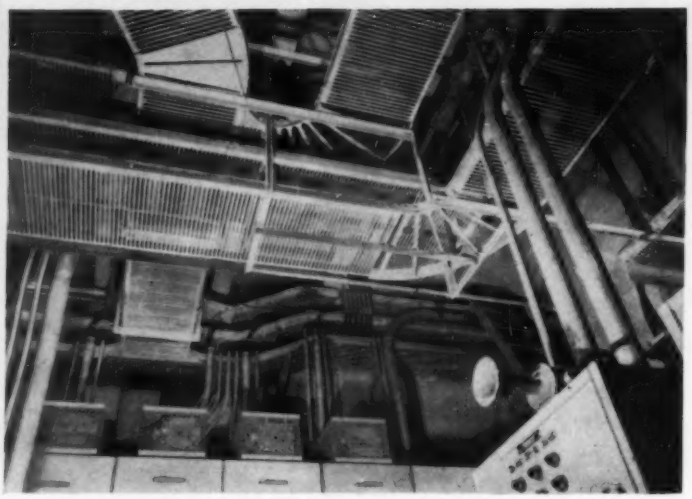

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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NUCLEAR SUPERHEAT—THE NEXT STEP

ON MAY 6, the General Electric Company announced that steam superheated by atomic energy had been produced at its Vallecitos Atomic Laboratory near Pleasanton, California.

Offhand, this may have seemed somewhat of a routine announcement, but to those of us in the nuclear field, it represented a most important milestone on the road to economic nuclear power. Despite the remarkable advances in nuclear power reactor technology in recent years, one of the drawbacks to nuclear power, at least in the minds of power engineers, has been the relatively low steam temperatures available from the existing nuclear reactors — temperatures in the range of 550 degrees. Modern high pressure steam plant practice is based on steam temperatures of 1000 degrees or even higher. Thus, to the power engineer accustomed to these higher temperatures, steam at 550 or 600 degrees is a retrogression; these temperatures were in vogue 30 years ago.

From the beginning, the idea of developing nuclear superheat has been in every reactor designer's mind, but until the recent development of oxide fuels, there was little chance for success in this direction. The temperature limitations of metallic uranium, coupled with corrosion difficulties at high temperatures, made the design of high temperature reactors extremely difficult from both a technical as well as an economic standpoint. The development of uranium dioxide as fuel changed this situation materially. While UO_2 has shortcomings in the way of lower density and lower thermal conductivity as compared with metallic uranium, its high melting point and its freedom from corrosion more than compensate for these shortcomings. As a consequence, most of the recent power reactor designs involve the use of this fuel. Uranium dioxide has a melting point in the vicinity of 5000 F, which is far above the temperature needed to produce suitable superheated steam for high thermal efficiency power cycles.

The practical demonstration of the feasibility of producing superheated steam in a nuclear reactor is therefore of significant importance. The impact of this work already is reflected in the intense interest on the part of manufacturers in offering to build reactors with nuclear superheaters. The experimental production of superheated steam at Vallecitos is only the initial phase of extensive research and development work before the construction of a large atomic plant using superheat can become a reality, but the basic principles seem to have been worked out and no serious difficulties are expected. The General Electric experiment uses UO_2 ceramic fuel to heat steam from the boiling water reactor. Nuclear superheat applications are expected in target boiling water reactor plants which would operate at a cost of about 6½ mills per kilowatthour by 1970.

Andrew W. Kramer

Hinkley Point—

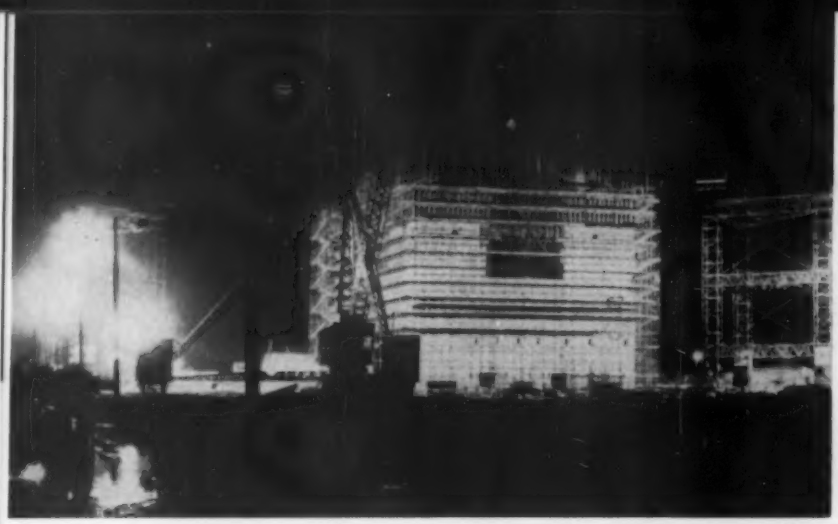

Fig. 1. A view of the construction of Hinkley Point Station at night. This 500-Mw plant is the largest nuclear power station actually under construction in England. It is expected to produce power at 0.65 cents per kwh

THE TIME for the introduction of nuclear power on a large scale depends on the individual circumstances of each country. In Great Britain, because of the critical fossil fuel situation, the need for nuclear power is most pressing and will intensify from 1965 onwards. For this reason Britain decided to make a start in 1955 and launched a nuclear power program to produce 1500 to 2000 Mw of electricity by 1965. Two years later, in 1957, the encouraging experience with Calder Hall led the British Government to increase the program, which now stands at 5000, to 6000 Mw by 1966.

The British have steadfastly held that nuclear power on any large scale must be economic and competitive with other sources. The initial stations will enjoy the advantage of being used for base load operations, and some will be in high coal cost areas. These stations will produce electricity for between 0.66d and 0.7d per kwh, compared with a corresponding conventional power cost of 0.64d in high cost coal areas and 0.53d in low cost coal areas.

At present the capital costs of nuclear stations are three times as high as those of conventional plants, but the fuel costs are much lower. The next step for Britain is to reduce these capital costs so that from 1966 onwards the nuclear stations will be competitive at lower load factors. While the first generation of stations (the Calder Hall type) is still under construction, Britain is building a prototype advanced gas-cooled reactor which they are confident will enable commercial stations to be built in the second half of the 1960's at capital costs some 20 per cent less than those now being built. This reduction in capital costs will be achieved by high fuel ratings and temperatures. This necessitates slightly enriching the fuel with U-235, which is expensive, but the life of the fuel element, in which the uranium is in the form of oxide, will be considerably greater than in the current stations.

This need for enriched fuel will occur at the time when the first generation of stations is producing large quantities of plutonium. So considerable developmental effort is being devoted to the solution of the problem of substituting plutonium for U-235 in the advanced gas-cooled reactors. The early stations will be started on U-235 enrichment, but it is hoped that it will be possible to change to plutonium enrichment.

The next step beyond the advanced gas-cooled reactor is the development of a high temperature gas-cooled reactor; considerable preliminary effort is being given to this project.

Looking ahead beyond this family of gas-cooled reactors, Britain hopes to reach in the 1970's the major objective of building fast breeder reactor power stations. These will come from the development of the fast reactor experiment at Dounreay, which is due to go critical early next year, and the prototype station to follow. The fast reactor station should have very markedly lower capital cost, and it has the ability to burn plutonium and a proportion of natural uranium by fast fission; moreover, it will produce more plutonium than it consumes. Potentially, therefore, it has exceptionally low fuel charges and low capital costs; it may produce power in the United Kingdom under

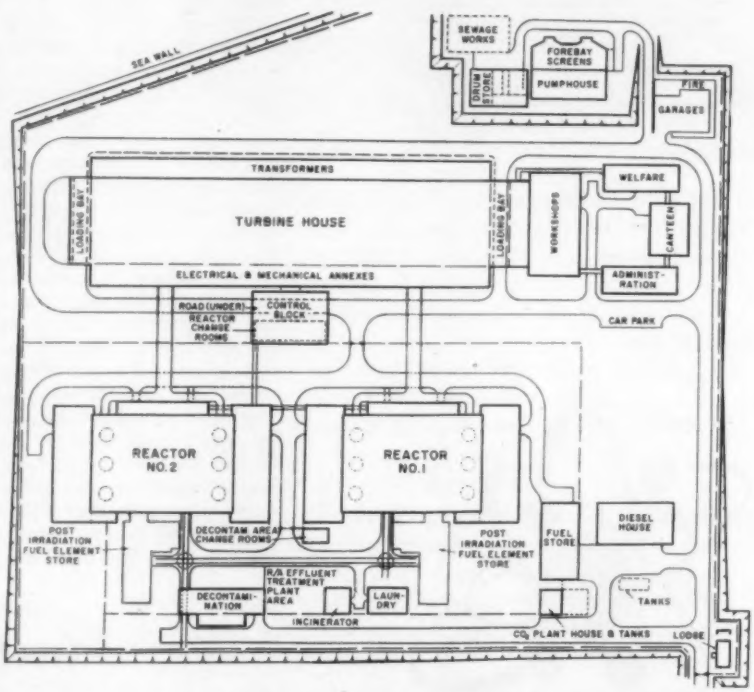

Fig. 2. General layout of the reactor buildings at Hinkley Point

ATOMICS

500 Mw of British Nuclear Power

base load conditions at less than 0.4d per kwh. While this reactor is very attractive, the development problems are severe, and this is why British engineers do not expect to build commercial fast reactor stations until the 1970's.

In the meantime, a number of very large nuclear power stations are being constructed, the largest being that at Hinkley Point, which is rapidly nearing completion. This 500-Mw plant is the largest now under actual construction, but an even larger station, one of 650-Mw capacity, has been ordered. All of these large stations are of the gas-cooled, graphite-moderated type, similar to Calder Hall but of much more advanced design.

Aside from its advanced design, the most interesting thing about Hinkley Point is that it is expected to generate electricity at a lower cost than any other nuclear station under construction. The expected cost is less than 0.65d per kwh. This is less than the national average in Great Britain today.

The construction of these large nuclear stations in Britain is an ambitious undertaking. The state of scientific and engineering knowledge at any time provides a framework of limitations within which it is necessary to work. The requirements of the system to which the station is connected may provide other limits, particularly in regard to size. The most obvious of the limits at the time Hinkley Point design was being prepared concerned the pressure vessel and the fuel. The general feeling was that the pressure vessel steel should be of a type well proved in similar service, and that for those parts to be site-welded, the thickness should not exceed 3 inches. Since it can be shown that a high pressure for the CO_2 coolant leads to economy, this maximum permissible thickness was chosen for the design. The limitations imposed by the fuel are of two types, nuclear and metallurgical. The economic requirement for a fuel burnup of at least 2500 Mw days per ton and preferably 3000 Mw days per ton, using natural uranium, immediately restricts, for nuclear reasons, the range of sizes and shapes which are usable. The metallurgical limits are partly the result of the relatively low maximum temperature, about 650 C, at which uranium can be operated for a short time, and about 600 C, at which it can be operated for long periods of time without completely losing its shape. A further similar limit of between 450 C and 500 C affects magnesium, the only suitable canning material for the Calder Hall type of reactor.

The design of Hinkley Point is based on the use of a nominal maximum fuel can temperature of 430 C, with an absolute maximum temperature 30 deg C higher than this. A pressure vessel diameter of 67 ft was selected as being probably suitable for the desired output. A series of lattices was calculated, involving pitches in the range of 7.5 inches to 8.5 in. using cylindrical uranium fuel rod, diameters of the order of 1.10 to 1.15 in., and lengths between 21 and 31 ft.

The heat transfer from fuel element to coolant was calculated from experimental data for the more interesting of these lattice configurations. Since the power to circulate the coolant is about two-thirds of the parasitic load on a gas-cooled, graphite-moderated type of station, it is necessary to relate the assumed heat transfer and nuclear performance of the fuel to the power demands of the gas circulators. Similarly, the pressure drop of the CO_2 in ducts, in boilers, and in entrance and exit from the pressure vessel must be carefully assessed. Here an arbitrary, but probably wise, restriction of 5 ft 6 in. was placed on the internal diameter of the flexible bellows joints needed to accommodate thermal expansion of the main gas ducts. A large number of possible schemes was drawn, over 30 in all, and the pressure drop was calculated in each case.

Using the figures for gas flow and pressure drop, it was possible to determine the blower power required and to incorporate figures for efficiency of the blowers and drives.

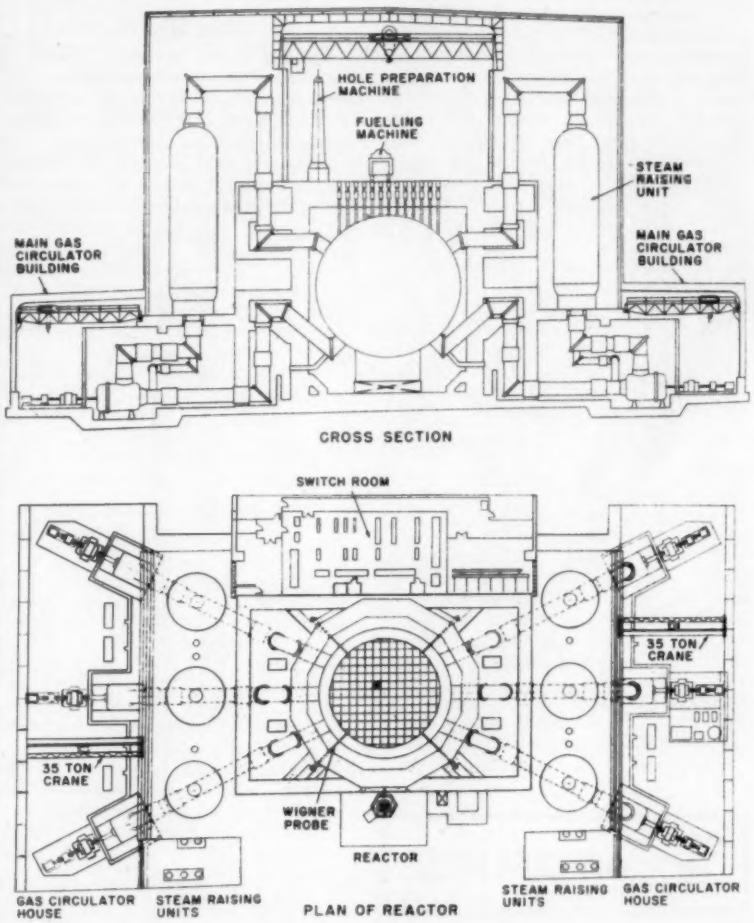

Fig. 3. Reactor No. 1 Cross Section and plan at floor level, showing the arrangement of the steam generators

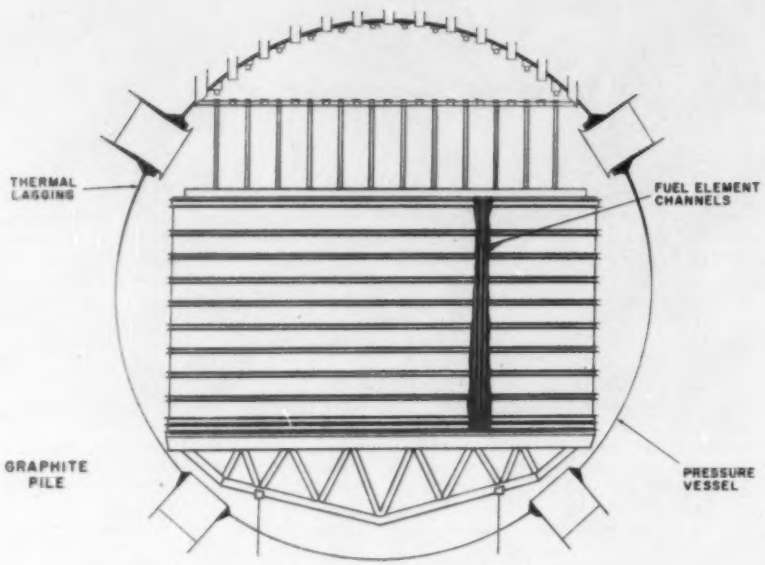

Fig. 4. Hinkley Point Core. The graphite blocks are about 30 in. long. The general shape is a 24-sided prism, carried on ball bearings to allow for thermal expansion

As a result of many studies of this type, the main station parameters for Hinkley Point were chosen, as listed in the table on page 47.

Station Layout

The layout of Hinkley Point station was determined basically from considerations of economy, ease of operation, ease of control, safety, and ease of construction. The turbine house is arranged nearly parallel with the sea wall and parallel with the line connecting the centers of the two reactors which are on the landward side of the site. The arrangement of the buildings was determined partly from reasons of economy of pipe and cable runs, but largely by the decision to use a Goliath crane for erection of the heat exchanger shells and the pressure vessel sections. This Goliath crane has a span of 250 ft, a clear height of 210 ft, with a lifting capacity of 400 tons on the main hooks. It is able to span each reactor and its associated building in turn.

The general layout of the reactor buildings is shown in Fig. 2. As shown, three boilers and their associated ducts and carbon dioxide blowers are located on the east and west sides of each reactor. On the north side of each reactor is an auxiliary building housing the bulk of the equipment needed for CO_2 storage, vacuum systems, flux measurement, electrical supply, control rods power supply, fuel element failure detection, and shield cooling. The equipment on the south side of each reactor includes a test facility for the fueling and hole preparation machines, discharge arrangements for spent fuel, and access shaft to allow heavy equipment to be lowered from pile cap to ground level. At pile cap level the space is largely devoted to fueling and servicing operations on the reactor.

Gas Circuit

The spherical pressure vessel is constructed of a boiler-quality mild steel, relatively immune to radiation damage. By a combination of internal insulation of the top of the vessel and carefully designed air cooling arrangements, it is possible to maintain the vessel temperatures everywhere between 600 and 650 F. At the top of the vessel approximately 200 standpipes are provided, one for each group of 36 fuel channels plus extras to carry control rods and flux scanning gear.

One of the major improvements in the Hinkley Point design has been the provision of an open girder type of support structure to carry the graphite. This open structure passes the gas flow from the bottom ducts to the fuel channels with the consequent possibility of raising the graphite volume in the sphere to about 40 per cent of the whole volume of the sphere as compared with about 30 per cent in previous designs.

The boilers are of the same general type as those used at Calder Hall but are much improved. In particular, the efficiency of space utilization inside the shell is greatly improved by shaping the tube banks to fit closely to the shell and to the inspection passages. In addition, the detailed design of the studded tubes has given both greater heat transfer per foot run of tube and lower pressure loss per unit of heat transfer.

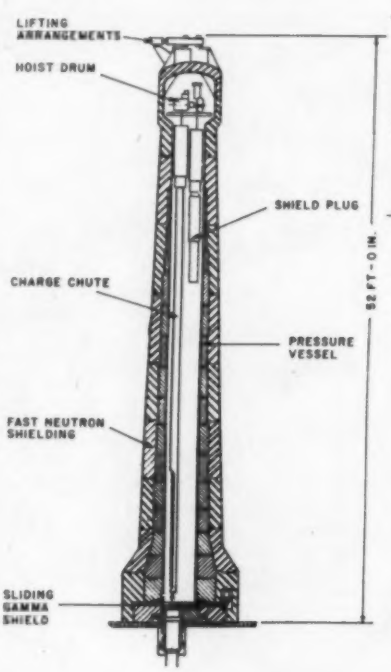

Fig. 5. Cross section of the hole preparation machine

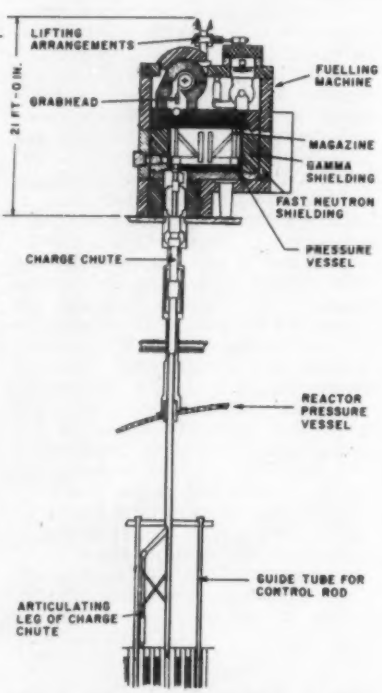

Fig. 6. Details of the fueling machine and charge chute

ATOMICS

The design is also helped by the higher CO_2 pressure. The volumetric heat rating is about twice that achieved at Calder Hall. Each boiler will handle over 160 Mw of heat compared with about 50 Mw each at Calder.

The CO_2 circulars are single-stage, axial flow fans with overhung rotors operating at nearly 3000 rpm. The method of blower drive deserves special mention. As the heat output of a gas-cooled reactor is varied, it is highly desirable to vary the gas flow in proportion. This will maintain all temperatures roughly at their full load value and thus give best part load efficiency, at the same time facilitating rapid load changes and minimizing trouble from varying temperature gradients through the fuel and reactor core. The power required by each blower is about 5500 hp at the design point with 7000 hp provided for either overload capability or to provide against a possible long term deterioration of the system. At this power, without using gearing, only direct steam turbine drive or squirrel cage induction motors appeared suitable. On the grounds of providing the smallest possible maintenance outage, the squirrel cage motors were chosen, and variable frequency turbine alternators were selected to provide the power.

This scheme, although certainly not the cheapest, was selected as that involving the least uncertainty. The controlled speed range is from 750 to 3000 rpm.

MAIN STATION PARAMETERS

REACTOR	
No. of reactors per station	2
Reactor heat rating	966 Mw
Diameter of pressure vessel	67 ft
Thickness of pressure vessel (excluding internal insulation)	3 in.
Coolant	CO_2
Nominal maximum can temperature	430 C
Reactor inlet temperature	178.9 C (354 F)
Reactor bulked outlet temperature	373.3 C (704 F)
Reactor inlet pressure	185 psig
Reactor gas mass flow	10,300 lb per sec
Total reactor pressure drop	4.45 psi
Total gas circuit pressure drop	8.63 psi
BOILERS AND TURBINES	
No. of steam raising units	12
HP steam pressure at superheater outlet	640 psig
HP steam temperature at superheater outlet	685 F
LP steam pressure at superheater outlet	170 psig
LP steam temperature at superheater outlet	660 F
Total steam flow from steam generators per reactor	2.76×10^6 lb per hr
Total HP steam flow from steam generator per reactor	1.76×10^6 lb per hr
Total LP steam flow from steam generator per reactor	1.00×10^6 lb per hr
No. of main turbines	6
Output of each turbine	87 Mw
No. of variable frequency turbines	3
Load on variable frequency turbine per reactor	25.2 Mw
Heat transferred to gas by circulators per reactor	22.9 Mw
Maximum capability of each V.F. turbine	33 Mw
Heat transferred from gas in boiler per reactor	986.2 Mw
MAIN CIRCULATORS	
No. of circulators	12
Type of circulator	single stage axial.
Blower temperature rise	5.0 C
OUTPUT	
Net electrical output	500 Mw
Net efficiency	0.26

The Reactor Core

The principal features of the core follow the lines laid down in the Calder Hall design. The graphite blocks, about 30 in. long, are located laterally by the double tile arrangement developed by the Atomic Energy Authority to provide for minimum Wigner growth in the vertical and two perpendicular horizontal directions. The general shape is a 24-sided prism, carried on ball bearings to allow for differential thermal expansion of the graphite and steel supporting structure. The tongue and groove keying system between bricks and tiles has been offset, to reduce gas leakage from the fuel channels, giving about a 2 per cent gain in reactor output.

The fuel element used at Hinkley Point contains a cylindrical heat-treated uranium rod in a helically finned can provided with a side support to limit bow which otherwise would take place. The elements are stacked in the channels and are handled from above for charge and discharge. The general features of the core are shown in Fig. 4.

In common with the other three commercial nuclear power stations being built in Great Britain, the Hinkley Point reactors will be refueled while operating at full pressure and full load. The operation will be continuous rather than batchwise. The advantages of this system are obvious. Interest and amortization charges alone on a 500-Mw station will amount to something like £15,000 a day. The difficulties with this system are not so obvious. The equipment provided is essentially four main machines, a crane for moving the various items on the pile cap, a *hole preparation* machine for handling shield plugs or other equipment normally found in a pressure vessel standpipe, a charge chute for carrying the fuel from the pile cap to the core and back, and a fueling machine to place and remove the individual fuel elements. Figures show the general arrangements of these machines.

Reactor Control and Instrumentation

The control and instrumentation of the reactor follow well-established lines. The control rods themselves are clad boron steel tubes, suspended by wire ropes from drums driven through a gear box by a slow speed synchronous motor supplied from a special variable frequency power source, with arrangements for moving the rods either simultaneously or in groups. Near the periphery of the reactor, one control rod for each 36 fuel channels is adequate, and in this region the rods are carried from special standpipes at the corners of each 6 by 6 group of fuel channels. If the power supply is cut from a control rod motor, the rod drops into the core under the action of gravity alone. The rod, however, is left connected to the motor, which acts as a generator and provides braking to regulate the speed of fall.

The reactor instrumentation is conventional. Alarm and control rod trips are actuated by the usual signals, high flux level, short doubling time, excessive temperature of fuel element, gas or graphite, excessive rate of change of gas pressure or flow, or blower failure. Trip circuits are normally two out of three coincidence circuits. Flux is measured by high level and low level ion chambers in a thermal column built into the biological shield. Fuel temperatures are measured by thermocouples provided with spring-loaded contacts pressing against terminals of leads permanently embedded in the graphite structure.

The main running controls for blower speed, control rod position, turbine throttle setting, and all important instrument readings are brought to a central station control room. Starting and supervision of the plant is, however, to be carried out locally. The station is designed to be run with constant low pressure and high pressure steam pressures which will be maintained by manual adjustment of the main turbine governor settings. This greatly simplifies operating procedure and allows both reactors to be connected to a common

steam range irrespective of their individual loads. Operating with a constant pressure of low pressure steam will produce a change of reactor inlet gas temperature in sympathy with load changes, but the magnitude of this effect is not great enough to affect the permissible rate of change of load because of thermal stresses produced in the boilers or pressure vessels. To avoid the thermal stresses, which might otherwise occur when the reactor trips from a high load, the control is such that the blowers are arranged to trip at the same time.

The safety of the reactors on shutdown is assured by two independent sources of power, a large battery, and automatic-start diesel engines. Among other items of equipment, these supply power to pony motors which automatically clutch in to drive the blowers at 10 per cent of full speed if the variable frequency power supply fails. A small d-c motor-driven boiler feed pump is automatically started to continue feed to the boilers. The relative height of the thermal centers of the boilers and reactor insures a natural convection flow of CO_2 large enough to remove fission product heating, and the water storage capacity of the boilers is large enough to absorb this heat for several hours even if no feed is available.

The Turbine House

The turbine house consists of a main hall, 640 ft by 135 ft wide and 90 ft high, with a north annex to house the main generator transformers; a south annex to house the auxiliary switchgear, mechanical plant and tanks; and a workshop at the eastern end. The six main turbine generators, each of 93.5-Mw maximum capacity, are arranged transversely, three at each end of the main hall, and the variable frequency sets of 33-Mw capacity are also arranged transversely in the center of the hall. The boiler feed pumps and the dump condenser plant are also located around the center of the hall.

At design rating, the steam conditions at the turbine stop valves are: for the high-pressure element, 615 psig, 680 F; and for the low-pressure unit, 150 psig, 655 F. The turbines have a single high-pressure cylinder and two double flow low-pressure cylinders coupled in line, each double flow cylinder exhausting into its own condenser. The intake for the circulating water system is in deep water about 700 yards out in the Bristol Channel.

The designers estimate that a staff of about 325 will be required to operate Hinkley Point Station. Of these only a few will be physicists. The bulk of the staff will be made up of the same general class of labor, supervisors and engineers as is normal for a coal- or oil-fired plant. THE END

Operating Experience at Vallecitos*

Operation of the first commercial boiling water reactor plant has been very satisfactory during the year and a half it has been in operation. Radiation levels have been low and have not interfered with normal operation or maintenance. Operation has been surprisingly stable.

THE VALLECITOS Boiling Water Reactor is one of the major research facilities of the General Electric Company's Atomic Laboratory at Pleasanton, California. It is furnishing steam to a turbine-generator owned and operated by the Pacific Gas & Electric Company. The 5000 kw of electrical energy produced is being distributed for commercial use by the PG&E system. Vallecitos is, however, primarily an experimental plant built to develop operational data and components for the Dresden Station of the Commonwealth Edison Company near Chicago. Since Vallecitos went into operation on October 24, 1957, it is of interest to examine the operating record of this first privately-financed nuclear power reactor to go into operation in the United States. Since this is a boiling water reactor system in which the steam produced in the reactor passes directly to the turbine, it is of particular interest to know what problems, if any, were encountered in handling the slightly radioactive steam.

One of the purposes of the Vallecitos reactor is to test various types of fuel elements, in particular those for the Dresden Station. These consist of cylindrical pellets of UO_2, one-half inch both in length and diameter and encased in Zircaloy tubing. Irradiation of the first of these prototype elements was started in November, 1957. The reactor presently contains 14 of these Dresden fuel assemblies, each containing nine fuel rods. Thus far there has been no evidence of weld or mechanical failure, although one of these assemblies has developed about 1700 Mwd per ton of exposure. While this does not provide all the data that is expected from the life testing of these elements, the results have added substantially to confidence in basic design, material selection, and manufacturing processes. It is planned soon to increase the number of prototype assemblies to 50. One assembly was operated at 110 per cent of the Dresden full load peak heat flux to check mechanical integrity. No detrimental effects were found. Irradiation tests are being made on several types of oxide fuels, including one manufactured by the swaging process.

During these tests, only one defect was found, and this was not in a Dresden-type element. It was apparently due to a cracked piece in the fuel assembly which was not detected during assembly. The ease of detecting this leak and the replacement of the element is worthy of mention. Following a fuel loading, unusual amounts of radioactivity were detected at various parts of the system an hour after the reactor reached operating power. This resulted in automatic shutdown from stack gas activity. Since it was considered possible that the activity could have been caused by very small quantities of uranium on the surface of the one new element in the core, the plant was started up again a few hours later. The high activity persisted, however, so the reactor was again shut down and the suspect element removed. Gamma radiation measurements outside the turbine casing were not dangerous but would reach about ten times normal during the first of the runs and decayed with an initial half-life of about an hour and a half. Twenty-four hours after the initial measurement, the activity was back to normal.

Equipment and Plant Operation

Development and testing is continuing to improve and lower the cost of manufacturing fuel elements. New fuels of varying design and composition are being tested under this program.

Radiation levels in the turbine and reactor building operating areas have not been a problem. Since the plan went into operation a year and a

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* Based on an address by J. R. Wolcott, Manager of Manufacturing for the Atomic Power Equipment Department, General Electric Co, San Jose, California.

half ago, the exposure for 35 personnel averaged 222 mr. The most that any individual received was 390 mr. Six people received exposures of 300 mr or more per year — *the allowable dose for one week.*

The turbine and generator are accessible at all times. Average radioactive readings range from one to 15 mr per hr, depending upon the turbine load. Activity levels are higher at the demineralizer, air ejector, and steam purifier. Maximum readings at these points are 1200, 100, and 80 mr per hr, respectively. Activity at the air ejector, steam purifier, and turbine are due mainly to N^{16}. Because of the relatively short half-life of N^{16} and the transit time of steam from the reactor to the turbine, activity readings vary widely with change in turbine load and steam flow. For example, the radiation level increases by a factor of three when the turbine load changes from 4.0 to 6.8 mw(e). Radiation level in the reactor enclosure remains unchanged.

Maintenance

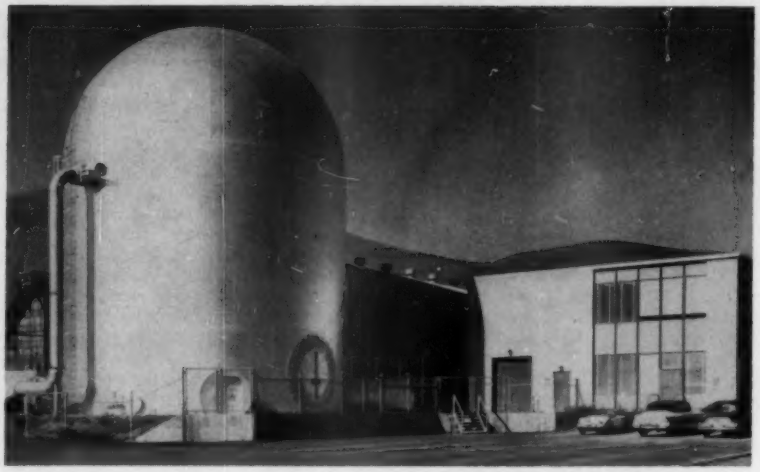
Maintenance work is performed regularly on the turbine, generator, exciter, feed pumps, and steam and condensate piping. Radiation levels have been sufficiently low to permit working a full shift, using normal power plant procedures. Turbine work has consisted of removing the high pressure casing, inspecting the turbine rotor and diaphragms, and making temporary repairs to the high pressure steam seal packing. Repairs were required because the turbine was originally designed to operate in a power system with superheated steam and is now using a lower temperature saturated steam.

The principal long-life radioactivities encountered have been due to stainless steel corrosion products. They were found to be deposited, for the most part, in areas of the turbine and in piping and fittings where velocities are low. These deposits did not contribute to the overall radioactivity level. Levels inside the turbine averaged about one mr per hr gamma and 20 mrad per hr beta.[1] In the steam leak areas, the beta activity was approximately 200 mrad per hr.

The turbine was operated and inspected after 900 hours of operation and again after 3000 hours of operation. Materials installed in the turbine to protect against attack by the wet steam have proved to be satisfactory.

Maintenance work on the reactor has proved relatively simple. During the last four months, the reactor has been opened 13 times to install, remove, or rearrange fuel or equipment as part of the experimental program. In one instance less than 24 hours elapsed while the turbine was separated from the system. Refueling requires cooling a 540 F system down to approximately room temperature. It then requires heating to operating temperature. Because of the size and complexity of the Dresden reactor, these time factors cannot be applied directly to refueling of Dresden. It does demonstrate, however, that this task is straightforward and relatively simple. Radiation exposures have not been any problem in working on or around the reactor, although such precautions as wearing masks have been necessary when cutting into piping in the reactor system.

[1] The Rad (Roentgen Adsorbed) radiation unit is an adsorbed dose unit corresponding to an energy absorption of 100 ergs per gram of any medium. It can be applied to any type and energy of radiation that leads to the production of ionization. The mrad, of course, is the millirad, the one thousand part of a rad.



The Vallecitos Boiling Water Reactor plant near Pleasanton, California.

Stability

Operation has been surprisingly stable. The reactor has been operated at pressures of 900 to 1000 psi at all power outputs up to 30,000 thermal kilowatts with no signs of instability. Operation to date indicates that the power level is far from that at which instability might occur. During one day's continuous operation at a power output of 20,000 thermal kilowatts, the reactor operated for two hours with no control rod adjustment.

The reactor responds quickly and easily to changes in turbine demand. Turbine load can be increased from zero to full load in less than one half minute with no severe disturbance in reactor pressure.

A few tests have been made with dual-cycle operation to simulate Dresden conditions. The results observed have been explained and simulated on an analog computer. This helps confirm proposed techniques for simulating the Dresden reactor on the computer where dual-cycle operation has been thoroughly studied.

Instrumentation

Special instrumentation is being tested. One system continuously monitors neutron flux at selected points. Small ion chambers are installed in fuel elements and leads are brought out through the vessel lid. Three groups of three chambers were originally installed. One chamber failed during initial operation, and several have been damaged due to handling during refueling periods. There are still two chambers operating satisfactorily. Similar chambers are to be used for flux monitoring of the Dresden core.

Testing is in progress on an equipment for detecting and locating defective fuel elements. Experience is insufficient as to the adequacy of the systems from a practical operating standpoint, but the principles of operations have been proved sound. This type of system is being provided for Dresden.

Other Benefits

Operation of VBWR is producing benefits other than technical. One is training of engineers and operating personnel for nuclear power plants. To date, about 40 operators have been trained and licensed for General Electric and such companies as Commonwealth Edison and Pacific Gas & Electric. Operation of VBWR ensures that a trained crew for Dresden will be ready. Normal training period is two months. The trainee is assigned to one of the four regular shifts and works directly on all phases of plant operation with experienced operators. Normally the Vallecitos power plant is run by one foreman and two operators per shift.

Public interest and acceptance of nuclear power has been very gratifying. Visitors to the Vallecitos Laboratory and to VBWR are averaging about 1000 persons per month. Acceptance by the press and public in the Bay Area and vicinity of the Laboratory has been excellent. There have been no difficulties from the local population in connection with licensing or operation. Demonstration of an operating boiling water nuclear power plant is the most convincing evidence General Electric has to impress customers. THE END

New Nuclear Literature

One of the most complete and interesting reports in the field of nuclear research issued each year is the *Annual Report of Brookhaven National Laboratory*. The latest, issued July 1, 1958, is no exception. It covers all aspects of Brookhaven's operations in considerable detail. Brookhaven National Laboratory is a regional research center where fundamental research is carried on in the nuclear sciences and related subjects. Its interests range from the most fundamental theoretical and experimental work in neutron physics and equally profound researches into complex biochemical reactions to the development of power reactors and high energy particle accelerators. The major activity in the latter area is the construction of the 25-Bev Alternating Gradient Synchrotron which has been under way for several years. The design and construction problems involved in this project are almost beyond comprehension. The diameter of the synchrotron ring is 843 ft. Surveying of this ring is a continuous process. A complete survey involves 24 survey monuments which provides basic information for the location of the 246 magnet cores. After the erection of the high density shielding block in the target building, it was found that all but three monuments in the target building were within 0.005 in. of the specified distances, and all angles were within one second of 165 deg (inside angle). The description of the work on the accelerator, however, is only one of the many interesting features of this 173-page report. Copies are available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Price $3.50 * * * Of interest to those concerned with the commercial aspects of nuclear energy is the *1959 Atomic Industry Directory of Products, Equipment and Services*, just published by the Atomic Industrial Forum. The 130-page book provides data in depth through product and service "profiles" of more than 200 industrial organizations in the nuclear field. Products, equipment and services are listed under 40 major classifications and 130 sub-categories. Center spread of the book is a flow chart of the atomic industry. This publication is available from the Atomic Industrial Forum, 3 East 54th St, New York, N. Y. (Attention Department B), at $2.50 per copy. * * * Another report of commercial interest is one issued by the National Association of Manufacturers, entitled *Industrial Nuclear Development*. This is a report of the proceedings of a conference sponsored by the Nuclear Energy and Employee Health and Benefits Committee of the NAM and the National Industrial Council. It contains papers presented by various authorities exploring the many problems facing industry, state and municipal agencies and trade associations in the development of nuclear energy for peaceful use. These papers involve various aspects of safety to workers and the public, education, labor relations. As the report points out, not only top management, but all representatives in the chain of command, as well as officials in trade associations, and government agencies at all levels, must become aware of the many facets of this new industrial force. Copies of *Industrial Nuclear Development* can be purchased from the National Association of Manufacturers, 2 East 48th St, New York 17, N. Y. Price $2. * * * Much that goes on in the field of nuclear research involves the use of computers; indeed, computers are used to simulate nuclear reactors in many laboratories. It is for this reason that we review a new book entitled *Logical Design of Electrical Circuits* in this section — many workers in the nuclear field will find it of great interest. This book presents a thorough and systematic treatment of Boolean methods for analyzing relay, diode, and vacuum tube circuits — particularly as applied to the design of automation systems, computers and nuclear simulators. Great strides have been made in the past decade in the logical design of switching circuits. Until C. E. Shannon of the Bell Telephone Laboratories published his paper, "A Symbolic Analysis of Relay and Switching Circuits," in 1938, design engineers worked chiefly by inspection and empirical methods, developing a kind of switching sense or intuition. Shannon's work, based on George Boole's algebra of logic, was the starting point for engineers and mathematicians who wished to develop a more formal approach to switching circuit design.

Boolean or switching algebra is nothing more nor less than a formal way of showing the relationships between the two-valued variables involved in a particular switching function. It might seem strange that switching circuits could be designed by means of equations, but when it is understood that Boolean algebra is actually a system of symbolic logic, the process becomes less mysterious. Switches, contacts, circuits, can be represented by symbols, and the conditions of these things can be represented by other symbols. By the use of proper rules these symbols can be manipulated through complex relationships to determine desired end results. So, this is what this book is about; clearly and logically, using only simple mathematics and basic electrical laws, it explains Boolean algebra as a vital tool in circuit design. Thus, it should be of particular value to engineers who have no special background in switching circuits. If a *memory* can be devised to absorb a set of codified directions which determines the movements of the switching mechanisms, the result is a *robot* or an electric *brain*. Actually, the authors of the book used these logical methods in the construction of a photographic type-composing machine known as the Photon. *Logical Design of Electrical Circuits* by Rene A. Higonnet and Rene A. Grea is published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. It is a 220-page, 5½ by 9¼ in. book. Price $10.

By now, after some five years of nuclear power reactor development, there are available a number of technical books dealing with reactor design and construction. However, most of these require considerable background, and the average person finds them rather difficult. For this reason, a new small book entitled *Nuclear Reactors for Power Generation* will be welcomed by those who wish to obtain a general idea of reactor development without having to go into technical detail. This book, published by the Philosophical Library, presents an up-to-date survey of the most important aspects of nuclear power generation. It is based on an advanced lecture course at Heriot-Watt College, Edinburgh, Scotland, and should be of interest to engineers who will be associated with the building and operation of nuclear power stations without necessarily being responsible for their actual design. Separate sections are devoted to World Energy Requirements, Nuclear Physics, Types of Reactors, Materials, The Physical Basis of Reactor Design, Safety and Instrumentation, and Economics. Each section is written by an authority, and recent developments have been taken into consideration in preparing the material for publication. It is not a large book, running only 144 pages, but it is very readable and is well illustrated. The chapter on the physical basis of reactor design is particularly well done, presenting a complex subject in an easy to understand manner.

The book will be of value to all who require information on the latest developments in the field of nuclear power generation. Edited by E. Openshaw Taylor, the book is available from the Philosophical Library, 15 East Fortieth Street, New York, N. Y. The price of this latest work is $7.50.

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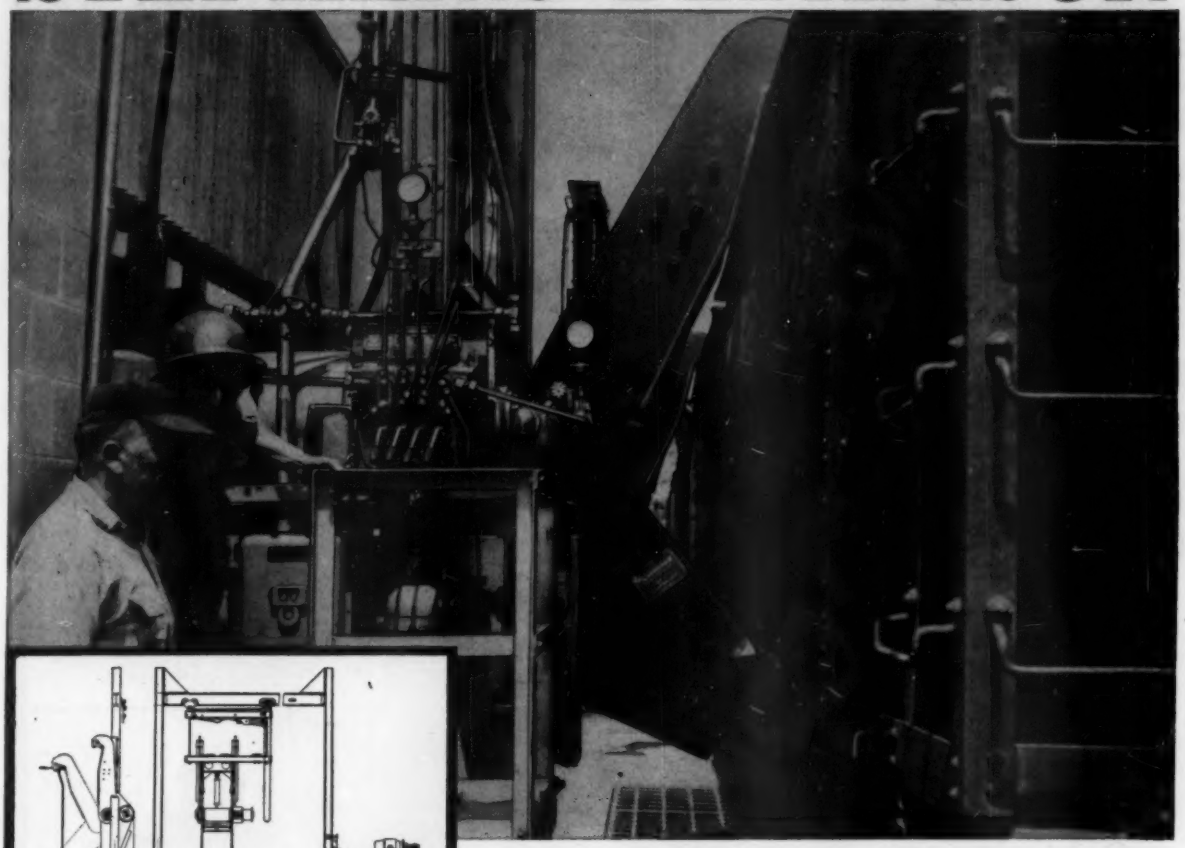

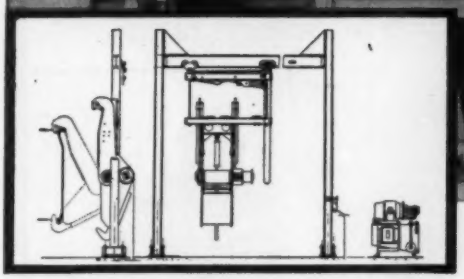

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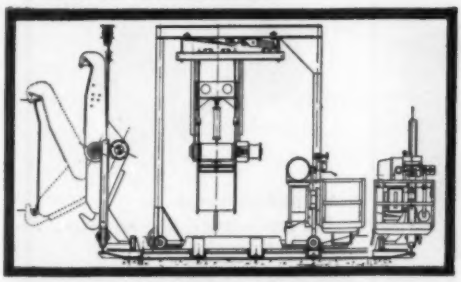

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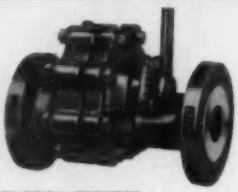

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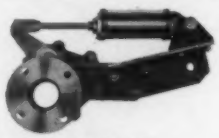

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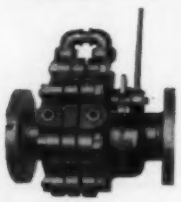

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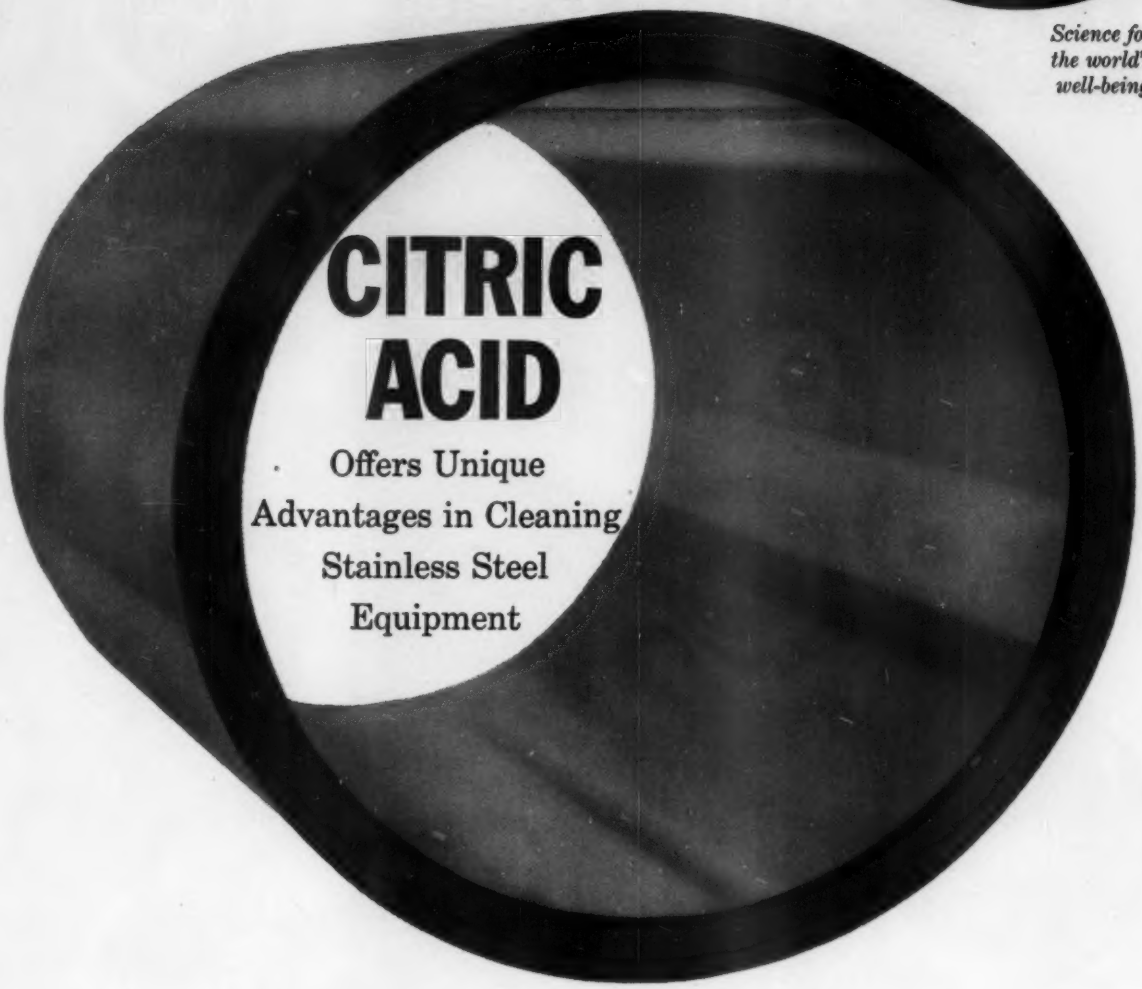

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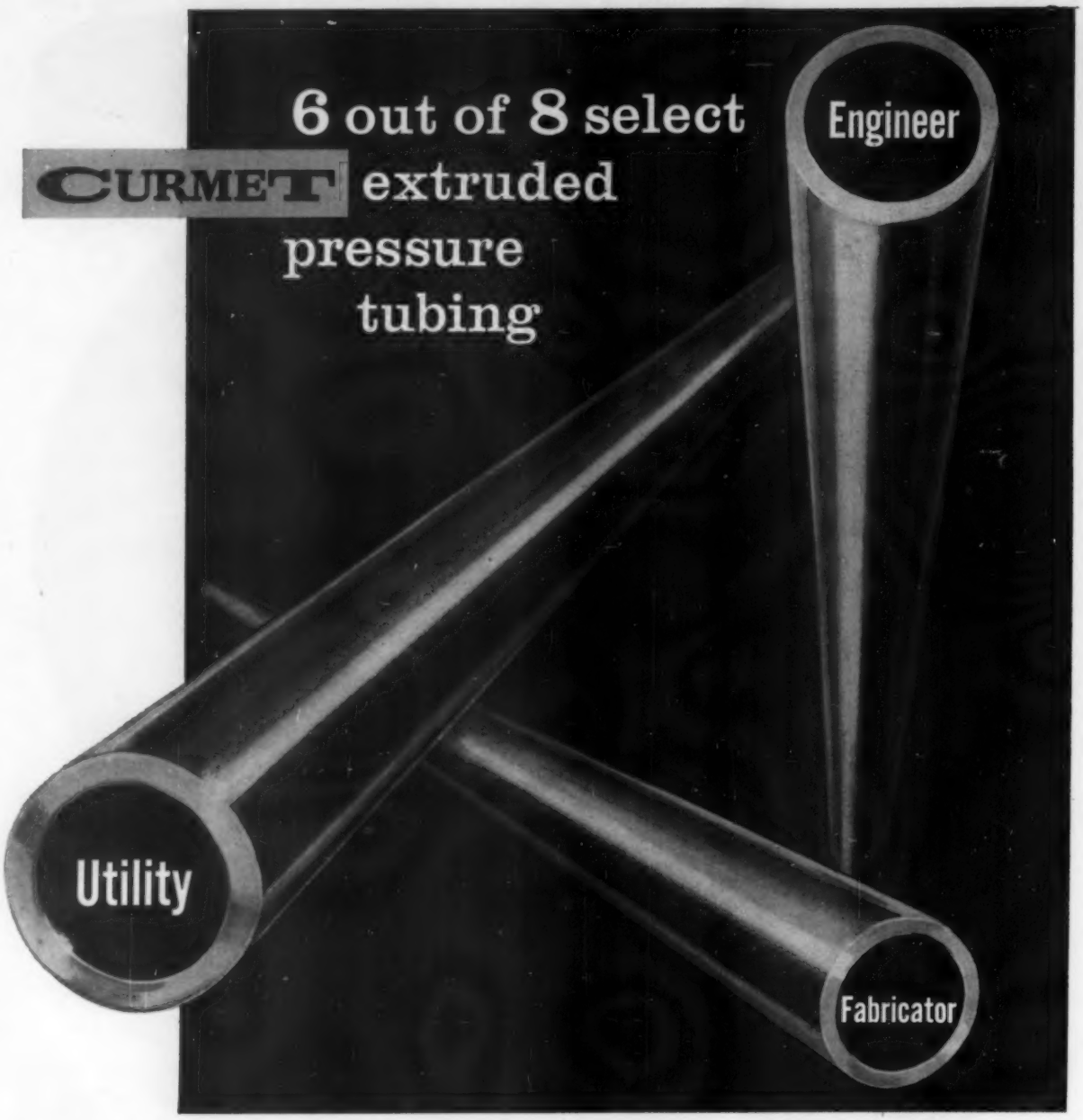

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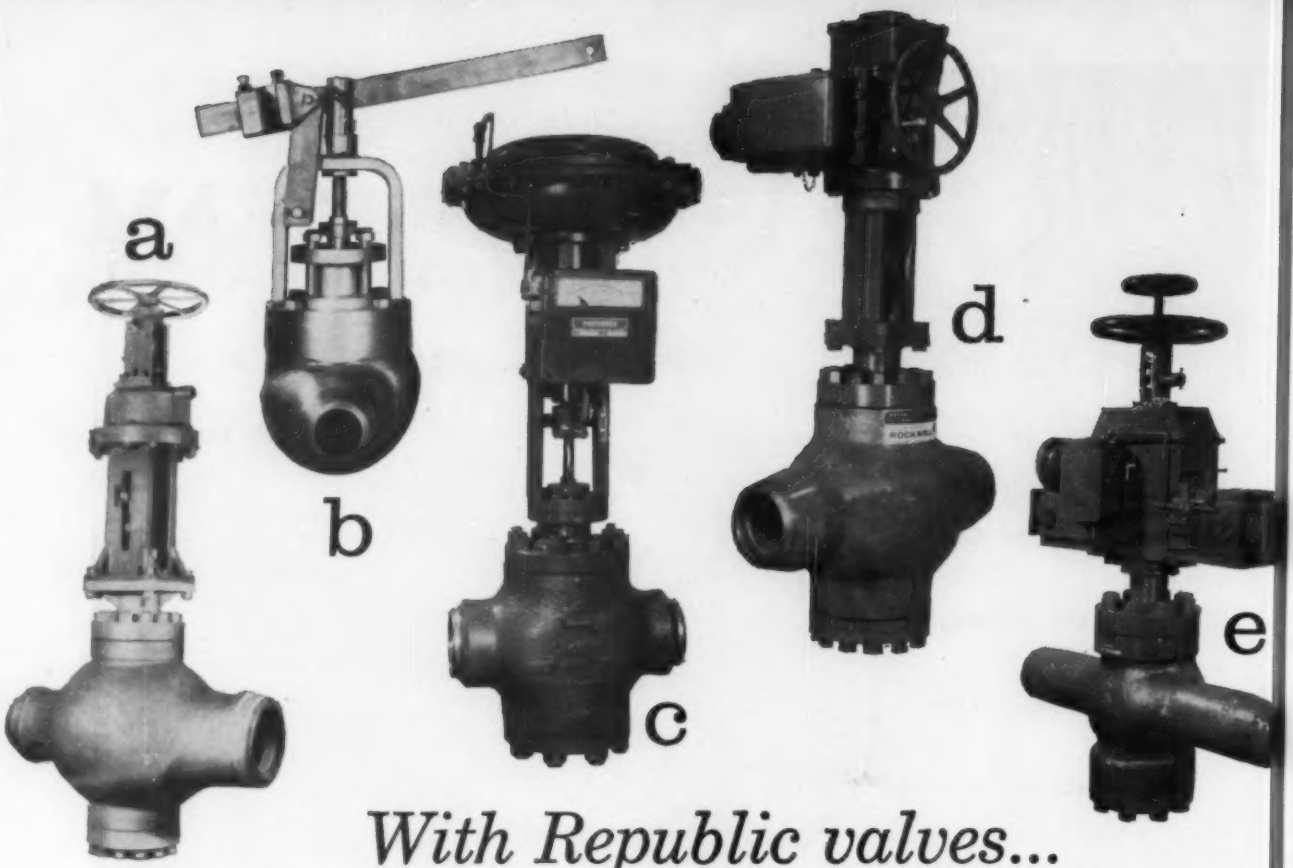

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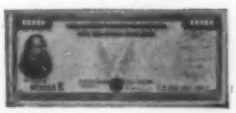

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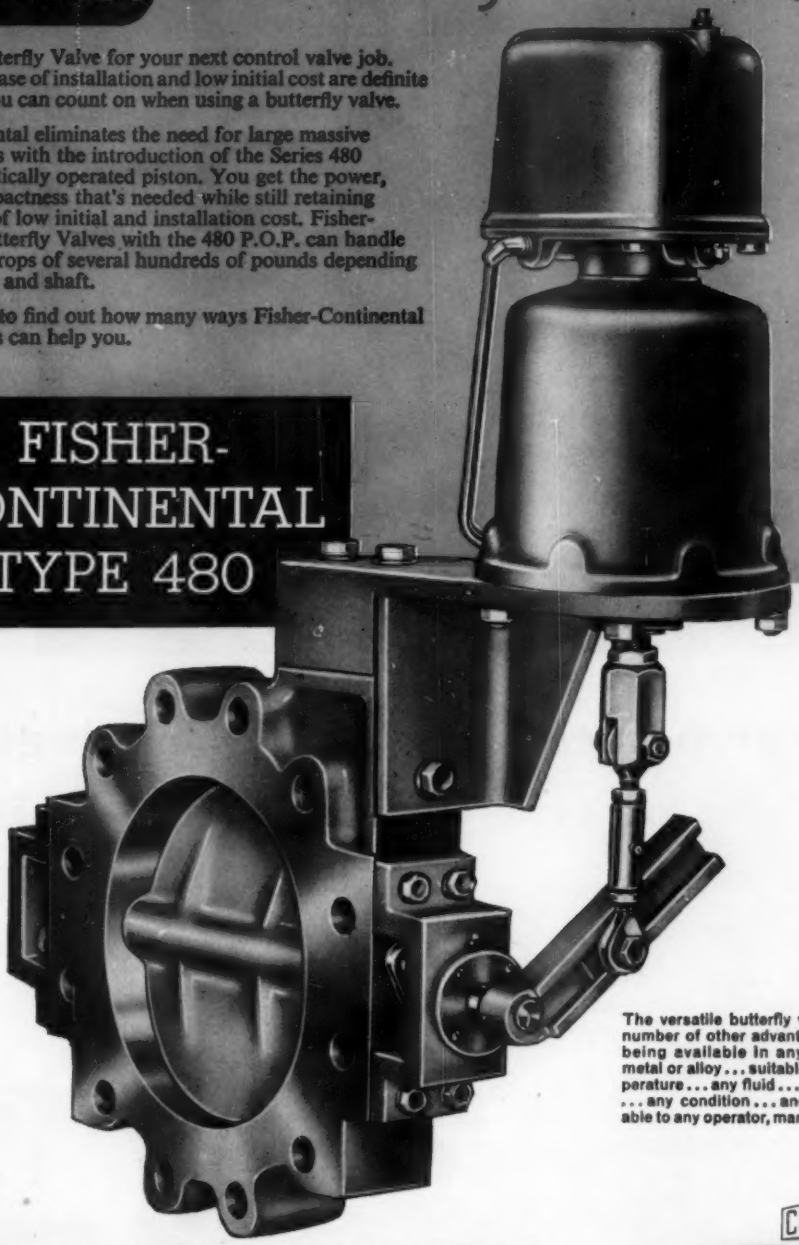

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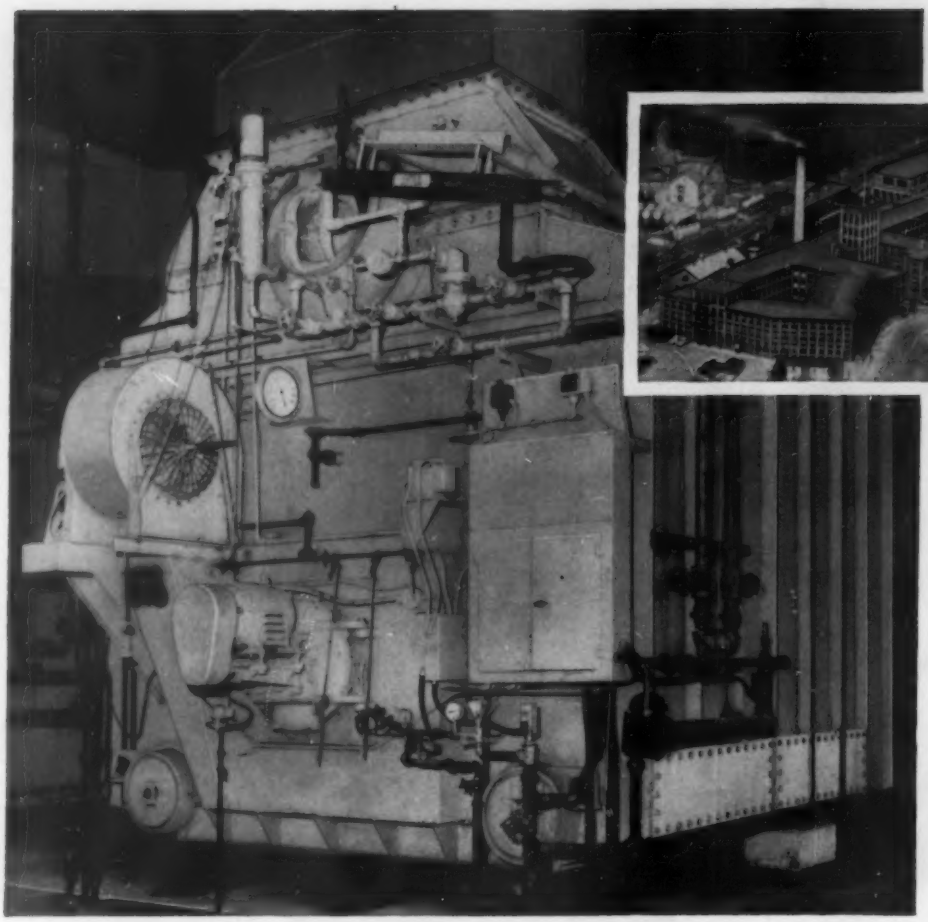

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Two reasons: (1) STANOIL is a superior oil. (2) Along with STANOIL, Hunter Packing receives experienced lubrication technical service.

A special antioxidant in STANOIL gives the oil resistance to *chemical* change. Deposits are minimized. The oil has a high viscosity index, is resistant to *temperature* change. It lubricates effectively at both high and low temperatures. Due to special refining techniques, STANOIL will not readily emulsify. A special additive minimizes foaming. STANOIL has a low pour point. It flows freely at low temperatures. A rust inhibitor in STANOIL "plates out" on metal surfaces.

W. P. "Sandy" Wehking, the Standard Oil man who calls on Hunter Packing Company, has plenty of experience in technical service work. He's been at it for 17 years. Sandy studied chemistry at Blackburn College. He has also completed the Standard Oil Sales Engineering School.

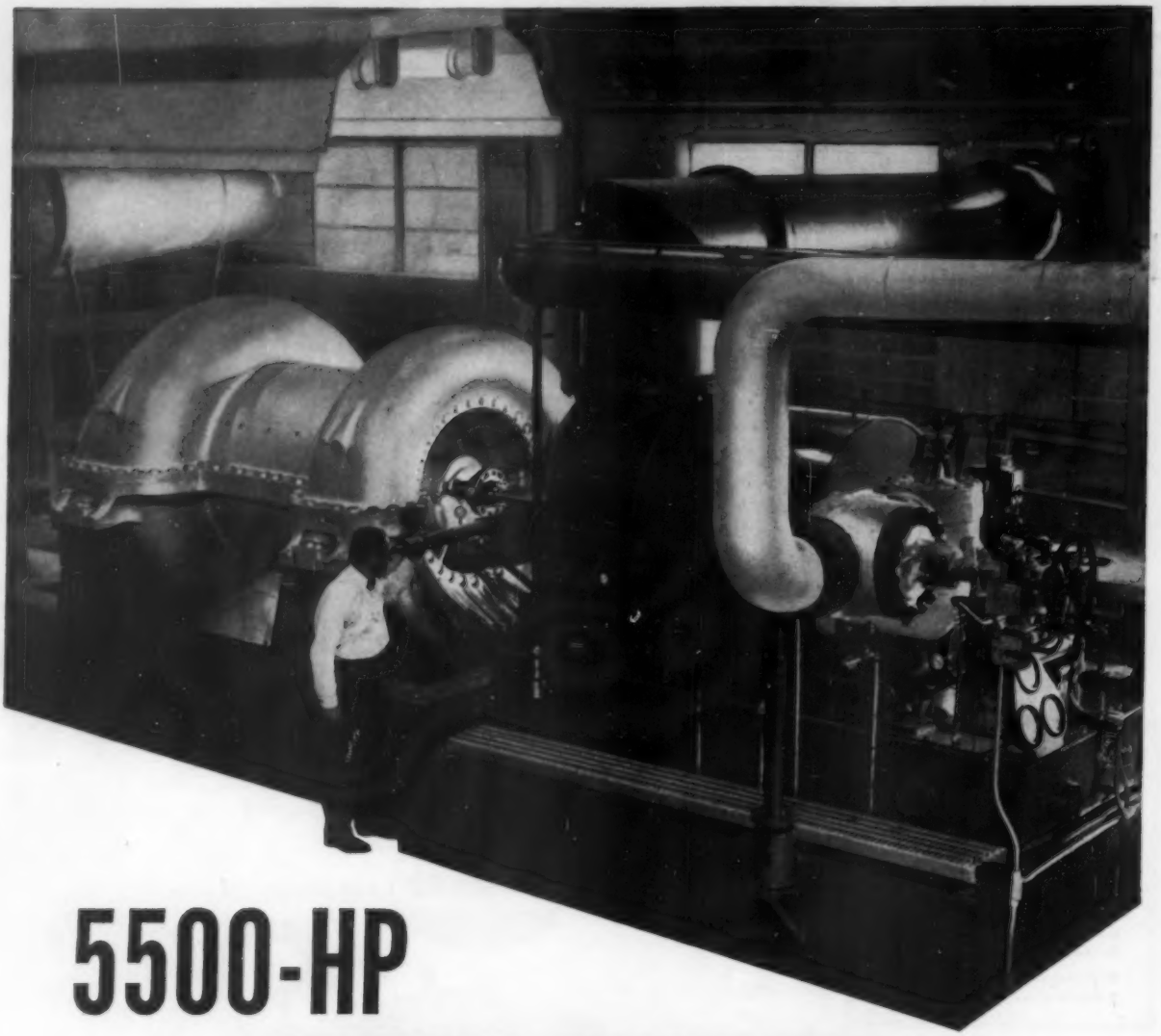
To get more information about STANOIL Industrial Oil and to obtain technical help on your lubrication problems, call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write, **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

Quick facts about **STANOIL Industrial Oil**

- Antioxidant gives oil resistance to chemical change, minimizes deposits.
- Inhibitor "plates out" on metal surfaces, prevents corrosion.
- Receives special refining to eliminate emulsion problems. Contains additive to minimize foaming.
- High viscosity index. Resists temperature change.

You expect more from STANDARD *and you get it!*

Temperature check. Frank Persson of Hunter Packing Company and Standard Oil lubrication specialist W. P. "Sandy" Wehking inspect one of four compressors in Hunter plant that uses STANOIL Industrial Oil.



5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

TERRY

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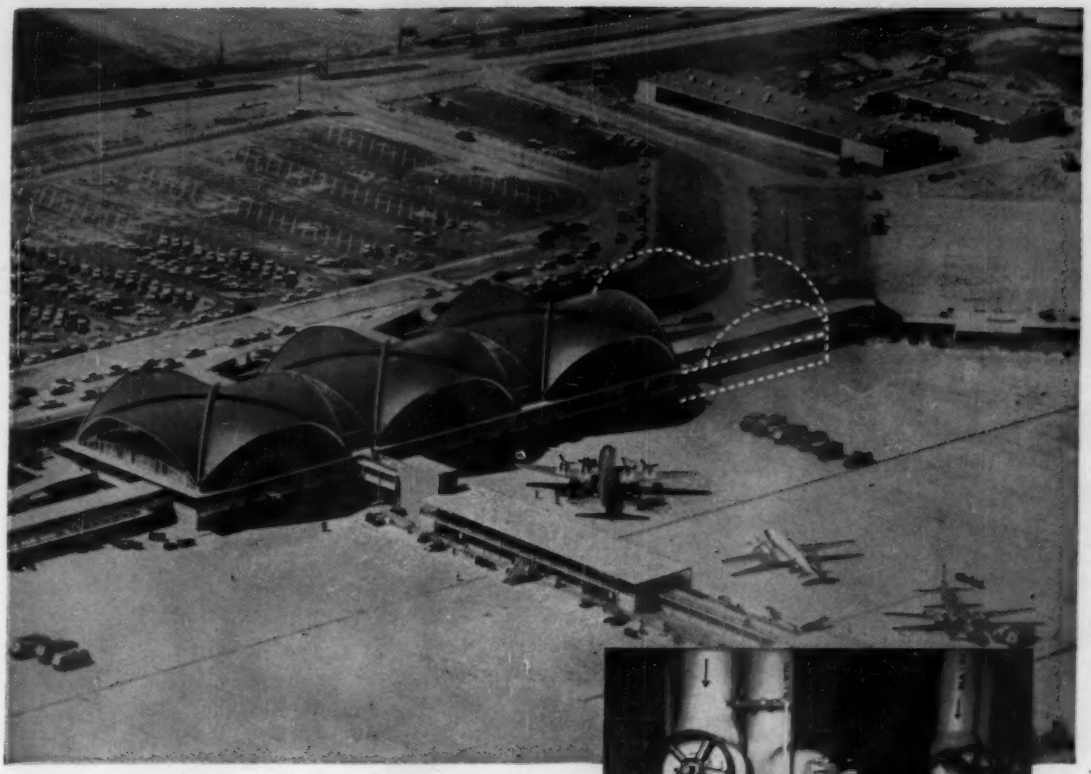

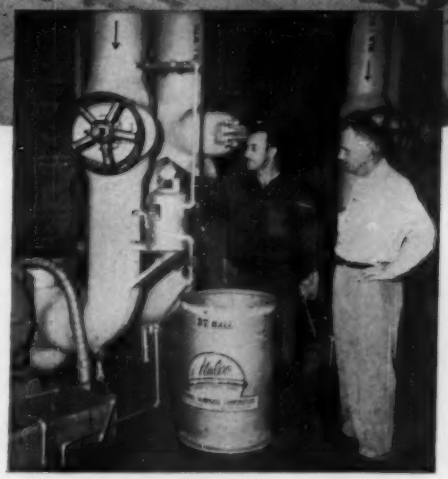

Top photo: Unusual modern architecture of St. Louis Municipal Airport Terminal Building is expandable in any direction. New units (dotted lines), can be added readily when required. Services buildings, *upper right*, are built and equipped with future expansion in mind. *Photo by Lloyd Spainhower.*

Lower photo: Nalco Chemicals and Services protect both boiler and cooling water systems at new St. Louis Airport. In this photo a Nalco cooling water treatment, supplied in ball briquette form, is being applied through the convenient Nalco feeder.

Nalco **protects vital services of new**

LAMBERT-ST. LOUIS AIRPORT

Functional efficiency is usually one of the hallmarks of fine architecture and it is apparent throughout the new St. Louis Municipal Airport Terminal Buildings.

Vital service facilities are housed in a low, clean-lined power plant, well separated from the present main terminal building in anticipation of planned expansion to accommodate increasing airline traffic. The Nalco System protects boiler and cooling water systems by effectively controlling scale, corrosion and microbiological growth . . . a non-architectural supplement to functional efficiency in *any* plant where water is used.

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Condensate seals the small control orifice against steam leakage under all normal operating conditions.

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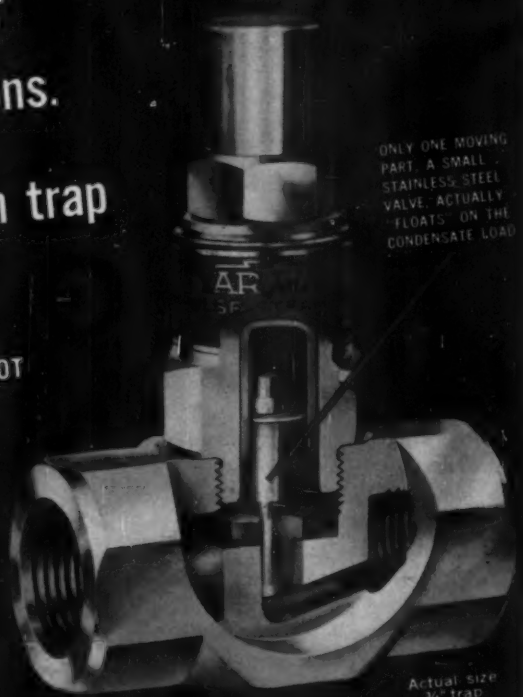

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TRACERS

Power Engineering's Monthly Probe of Power Facts

TAP-100 is the name for what is believed to be the most powerful thermoelectric generator ever built. It's a 100-watt generator developed by Westinghouse for the Air Research and Development Command. Weighing 40 lb and about the size of a medicine ball, TAP-100 can operate on a gas flame, converting the heat of the flame directly to electricity. It burns propane but is also adaptable to gasoline and kerosene, with a long-lived radioactive isotope as a fuel possibility for the immediate future.

Shielding of 13.8-kv distribution lines, using a ground wire over the distribution lines, has enabled New Orleans Public Service to realize a reduction in an outage record of 1.2 per 100 miles per thunderstorm day in 1950–51 to 0.8 in 1958. This represents a reduction from 90 outages per 100 miles of circuit in 1951 to 13.5 outages per 100 miles of circuit in 1958.

New Avon plant of Tidewater Oil Co is using fluid coke as primary fuel. For a discussion of operating experience with this new commodity, turn to the article by DeBenedetti, Farmer and Courtney, page 68.

Brazos Electric Coöperative, serving 14 counties in north central Texas, has added a new station at Weatherford, with two 16.5 mw units. Important automation features of the station will be discussed in a forthcoming issue. Operating conditions are 875 psi at 900 F. An indoor station, Weatherford was built at a cost of $158 per kw.

There's a new ion-exchange method for economic and efficient silica reduction in boiler feedwater, *without* demineralizing the water. Scovill Mfg Co has been experimenting with it in the plant at Waterbury, Conn. For details, see the article on page 93.

A million-mile "maintenance free" brushless generator for motor coaches was described at AIEE's Summer and Pacific General Meeting by R. L. Larson of Delco-Remy. The unit has been under limited production since 1958. It has no wearing parts other than continuously lubricated ball bearings, and the advantage of a regulator which has no moving parts.

General Electric's Vallecitos Boiling Water Reactor-VBWR, coupled with a Pacific Gas and Electric turbine generator, produced the first all privately-financed atomic electric power on October 24, 1957. Since that time the power output has been increased by 50 per cent with no change in design. The basic simplicity of the boiling water cycle coupled with its low cost holds great promise for the continued success of this type of reactor system, and it is of considerable interest to note that Consumers Power Co has just announced plans to construct an advanced high density boiling reactor plant with an initial capability of 50,000 kw (e), scheduled for operation in 1962. Operating experience with VBWR is described in the ATOMICS section, page 48.

Fluid Coke Is Primary Fuel

Capable of using up to 500 tons per day of the new commercial fuel, fluid coke, or fuel oil, or refinery gas, or any combination of the three, the new steam plant of Tidewater's Avon Refinery near San Francisco has many unique features, described in this article

By **H. B. DeBENEDETTI, F. H. FARMER, and E. F. COURTNEY** *

DURING THE LAST decade the petroleum refining industry has been faced with an ever-increasing demand for more gasoline while at the same time demand for residual fuel has been diminishing. As a result the fluid-coking process, licensed by the Esso Research and Engineering Co, has been widely accepted by the industry as a means of up-grading low-value residual fuel oil stocks into gasoline, gas oil, coke and gas.

Fluid-coking units have been installed as follows:

Company	*Location*	*Capacity BPSD*
Carter Oil	Billings	3,800
Esso Standard Oil	Baltimore	10,000
Canadian Petrofina	Montreal	3,800
Aurora Gasoline	Detroit	4,000
Tidewater Oil	Associated	42,000
Tidewater Oil	Delaware City	42,000
Bankline Oil	Bakersfield	4,000
Pontiac Eastern	Hattiesburg	4,800

In the fluid-coking process, small particles of petroleum coke serve as a heat-transfer media and circulate in a fluid state between a reactor and burner vessel. Hot residuum feed is sprayed through nozzles into a bed of coke fluidized with steam and process vapors in the reactor vessel at a temperature of 950 to 1050 F. Vapor products are taken overhead through cyclones to fractionation and further handling. Coke is formed on the small circulating coke particles and is transferred from the bottom of the reactor to the burner where fluidizing air burns sufficient coke to maintain process temperatures. Product fluid coke is withdrawn from the burner to storage at a temperature of 300 F.

Fluid Coke—A New Commodity

Product coke is a hard, dry, roughly-spherical solid resembling black sand. Table I shows the chemical and physical properties of Avon fluid coke. It is composed of over 90 per cent carbon with varying percentages of sulfur and ash depending on the source of crude, and about three to five per cent of volatile matter.

Due to the newness of the commodity and the unique physical and chemical properties, suitable markets have been difficult to develop. Many extensive research and development programs are under way to develop high-value uses such as electrodes for manufacture of aluminum and a carbon source for the metallurgical industry. High percentage of carbon and low ash content makes the product attractive for these industries but high sulfur and small particle size create problems.

The material has been highly acceptable to the chemical industry as a reducing agent for reduction of barium, lead and other ores, and for the production of carborundum and calcium carbide. Its high heat value and low ash has made it particularly attractive as a boiler fuel although the low volatility and hardness have required special grinding and burning techniques.

Coke-Handling Facilities

The small spherical particles of fluid coke lend themselves readily to transportation by air-borne conveying systems. Such methods are used to move coke from the Avon fluid coker to the boilerhouse storage bunker and to convey the coke to the boiler after pulverizing. Figure 1 shows how the coke is transported from the producing unit to the consuming unit and how it is manipulated up to the boiler burner.

Coke is received at the boilerhouse at 200 to 250 F. Particle size must be reduced in order to burn it efficiently in the boiler furnace.

Coke flows from the storage bunker by gravity, is weighed through automatic scales, and fed into Duplex Riley, Type 550, fluid-coke pulverizers.

Pulverizing Equipment

Pulverizer is an attrition-type mill. Coke particles are bounced against each other and against stationary and moving tungsten-carbide-faced pulverizer elements. These elements are on the periphery of the rotating element and fixed in the housing liners of the mill. Centrifugal force throws the coke radially outward in the mill and keeps the large coke particles bouncing and wearing until their size is sufficiently reduced.

When a small-enough particle size is reached, air flowing radially inward toward the pulverizer shaft overcomes centrifugal force and entrains the particles. These fine particles are removed from the mill's attrition section. The finely-ground, air-borne coke is then blown, by the pulverizer fan, out of the mill and into coke

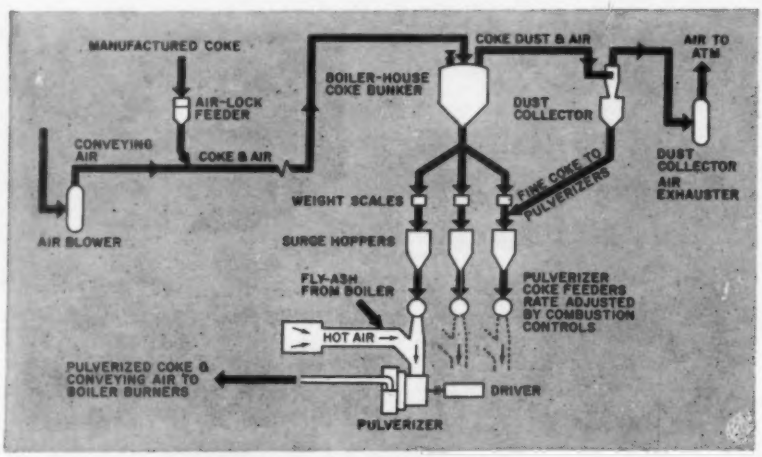


Fig. 1. Flow diagram of the coke-handling system. Transportation of the coke to the boiler-house coke bunker is through two 10-in., 1500-ft-long overhead lines

* Operating Foreman, Utilities, Supervisor of Plant Utilities, and Superintendent Shipping & Utilities, respectively, Tidewater Oil Co

el in New Avon Steam Plant

lines leading to appropriate boiler burners. Here the coke is burned with a supporting fuel in the boiler furnace.

Burning the Coke

Fluid petroleum coke is unlike coal or other solid fuels which contain more volatile materials. Fluid petroleum coke has a low volatile-material content. This makes fluid coke an extremely-safe fuel to handle but requires that it be burned in a furnace with a supporting liquid or gaseous auxiliary fuel.

Fluid coke has been burned in Tidewater's Avon Refinery boiler in many coke-auxiliary fuel ratios. These ratios have been from 10 per cent auxiliary fuel — 90 per cent coke to 90 per cent auxiliary fuel — 10 per cent coke. Flue gas O_2 during these operations has been as low as 1½ per cent at full boiler rating. In all cases extremely stable fires have resulted. No furnace pressure surges have occurred.

Burners are designed so that coke, gas, oil or combinations of these three fuels can be simultaneously burned. Burners are about ten feet above the furnace floor and are tilted approximately 35 deg downward and fire toward the furnace floor. Coke enters the top of the burner and gas or oil about one foot below the coke.

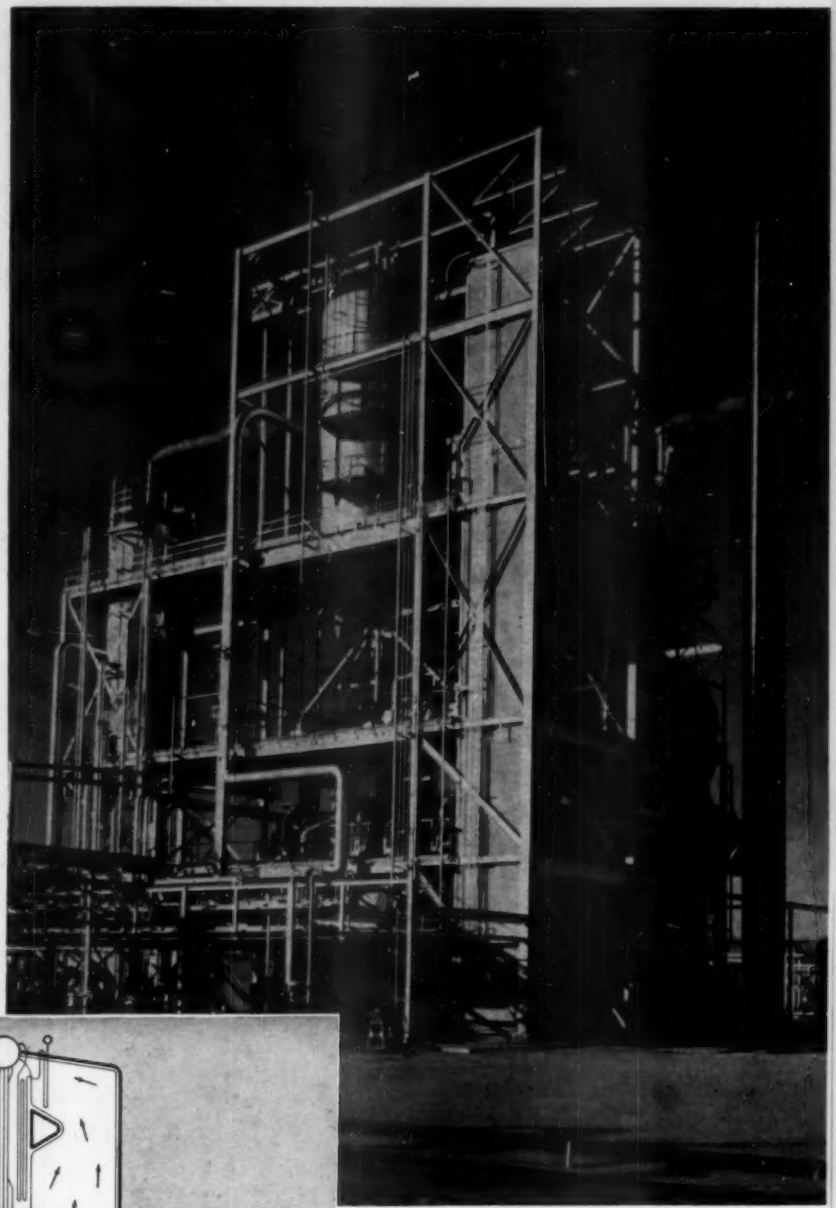


Fig. 3. Dramatic view of the new tri-fuel boiler plant, taken from the opposite side from the section shown at left

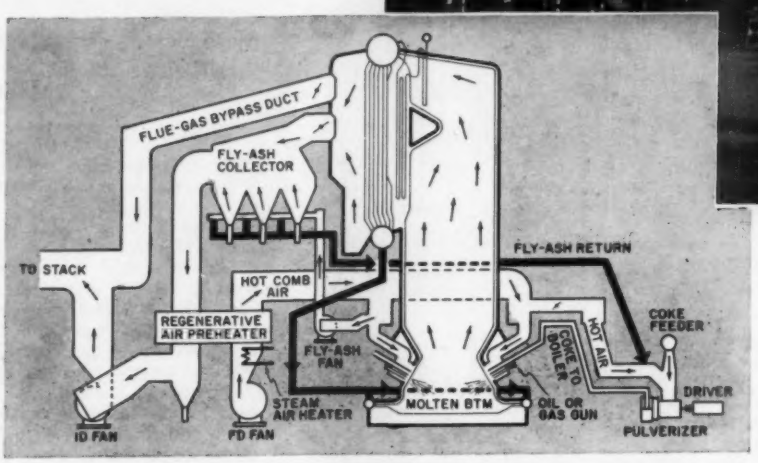


Fig. 2. Cross section of the coke-burning boiler. The superheater is to be installed when the full capacity of the boiler is needed for electric generation

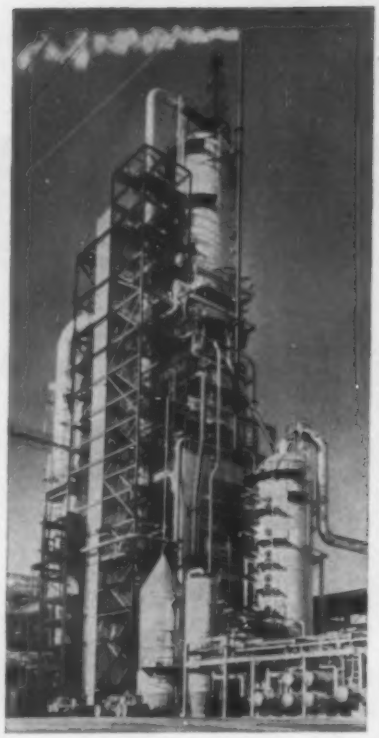


Fig. 4. World's largest fluid-coking plant. Note the height of the plant as compared with truck and road grader

Figure 2 shows the general layout of the boiler. Coke enters the furnace through twelve combination-fuel, directional-vane burners. Burners can be adjusted to elevate or depress the flames in the furnace bottom or to balance heat distribution in the furnace. This adjustment is beneficial in the removal of furnace-wall slag. Changing slag temperatures allows easy removal with air lancing.

Dust Collection

Rear of the boiler is fitted with a Prat-Daniel dust collector. Here flyash and a small amount of unburned coke is collected. This collected material is continuously removed from the dust hoppers and is returned to the pulverizers. Flyash and unburned coke recirculate until all combustibles are consumed. Non-combustibles in the flyash collect in the molten floor of the furnace.

Removal of the material deposited on the furnace floor is made by tapping the molten pool and draining off the accumulation. Six months of operation at Avon has accumulated only six inches of slag in the furnace bottom. This is attributed to the low ash content in the fluid coke.

Initial operation of the boiler was on fuel gas and Bunker C fuel oil. No difficulties were experienced. When burning coke, minor fouling of furnace tubes and superheater hot-end tubes was noted. Once-daily soot blowing in the superheater gives good removal of this fouling deposit. Furnace walls have required lancing, using 90-psig air, once in six months. The use of a furnace additive appears to also have aided in controlling slag deposits and easing their removal.

Operating at 80 per cent of boiler rating and above at high coke-burning rates appears to aid boiler cleanliness. This is attributed to the slight abrading effect of unburned coke particles striking the heat-exchanger surfaces. This impingement removes the slight accumulation on the tubes in the cooler sections of the boiler. This results in a direct benefit to heat transfer and is seen as a lowering of flue-gas temperatures leaving the boiler and entering the air heater. The unburned coke passing through the boiler is caught in the dust collector and reinjected into the furnace for ultimate burning.

Air Preheater

Dust-collector efficiency has been such that no change in pressure drop has occurred in the air preheater. Inspection of the preheater rotating element shows the heater to be in excellent condition and clean. The air preheater is given a cold end steam cleaning once every eight hours.

General boiler specifications are thus:

- Manufacturer, Riley Stoker Corporation
- Furnace designation, Turbo Furnace
- Capacity, 500,000 lb per hr at 600 or 1300 psig
- Design pressure and temperature, 1300 psig — 950 F
- Present operating pressure and temperature, 600 psig — 750 F
- FD and ID fans, Sturtevant
- Pulverizers, Riley Stoker Corporation Duplex, Type 550
- Boiler feed pumps, Pacific Pumps, Inc.
- Turbine drivers, Elliott Company
- Combustion controls, Bailey Meter Company
- Air preheater, Ljungstrom Air Preheater Co.
- Flyash collector, Prat-Daniel
- Boiler feedwater demineralizer, Graver

It will be noted that the boiler design pressure is 1300 psig and present operating pressure is 600 psig. The boiler was designed and erected for future use as a steam-electric-power-generating unit. No electrical generating facilities have been installed at this time. Present requirements need only 600 psig and 750 F steam. The boiler as erected has the headers but does not have the final superheater installed. Ultimate use for power generation will require the installation of the 950 F superheater.

Feedwater to the boiler is com-

Table I. Chemical and physical properties of Avon fluid coke reveal variations

COMPONENT	AMOUNT (ppm)	COMPONENT	AMOUNT (ppm)	COMPONENT	AMOUNT (ppm)
Ca as $CaCO_3$	68	HCO_3 as $CaCO_3$	80	CO_2 as CO_3	0
Mg as $CaCO_3$	90	CO_3 as $CaCO_3$	2	SiO_2 as SiO_3	13
Na as $CaCO_3$	150	OH as $CaCO_3$	0	Fe as Fe	0
H as $CaCO_3$	0	PO_4 as $CaCO_3$	0	Turbidity	39
	—	Cl as $CaCO_3$	142	pH	7.9
Total Cations	308	SO_4 as $CaCO_3$	84		
		NO_3 as $CaCO_3$	0		
			—		
		Total Anions	308		

Table II. Typical analysis of canal water shows extent of treatment necessary

PROPERTY	VALUE
Sulfur, Wt %	4.0 to 7.5% (Varies with source of crude)
Volatile Matter, Wt % (950 C)	3–5%
Heating Value (Gross), Btu/lb	14,300–14,600
Carbon, Wt %	90–95
Ash, Wt %	0.2–0.5
Vanadium, ppm	500–600 (Varies with source of crude)
Nickel, ppm	300–400 (Varies with source of crude)
Equivalent hardgrove grindability index	About 20
Apparent bulk density—lb/cu ft	55–65
Angle of repose	25–30 deg
Mesh analysis	

Mesh	Wt % On	
	Range	Typical
35	3–15	10
48	5–20	13
60	10–35	16
80	18–65	34
100	40–75	50
200	90–99	91

Ash-fusion temperature, 2550 F

posed of clean condensate collected from condensers on large steam turbines, and demineralized water produced in a new water-treating plant. Demineralization was selected as the method of water treatment in order to produce a water quality suitable for future boiler operation at 1300 psig.

Refinery receives raw water from the Contra Costa Canal whose source is the San Joaquin River. A typical analysis of this water is shown in Table II.

Water Pretreatment

Raw water receives a preliminary treatment before entering the demineralizer plant. It is continuously chlorinated to a residual of ¼ ppm as it enters a Graver upflow-type clarifier. Chlorination is used to control organic matter, which is considered poisonous to demineralizer resins. The clarified water is filtered in graded-bed anthrafilt pressure filters and then enters a 5000-barrel filtered-water storage tank located adjacent to the demineralizer.

Filtered water is dechlorinated by injecting sodium sulfite as it enters the tank. A residual of 1 ppm sodium sulfite is maintained. This is necessary as chlorine is also considered to be detrimental to demineralizer-resin life.

Demineralizer plant shown in Fig. 5 is a three-bed, two-train plant. Each train is rated at 500 gpm and has a primary cation exchanger, a primary anion exchanger, and a secondary anion exchanger. The trains can be operated individually or with the two trains operating in parallel.

Demineralizer Operation

Primary cation unit removes calcium, magnesium, and sodium. It is regenerated in two steps, the first using a 4 per cent solution of sulfuric acid and in the second the acid strength is increased to 6 per cent. No secondary cation unit is installed at present but full provision is made for its addition at a later date if and when it is needed.

Primary anion unit is weakly basic and removes chlorides and sulfate. The secondary anion unit is strongly basic and removes carbon dioxide and silica. The anion exchangers are regenerated using a 4 per cent solution of low-chlorate caustic. Chlorates are also considered to be detrimental to demineralizer-resin life, hence the use of low-chlorate caustic.

Upon completion of the regeneration periods the exchangers are backwashed and rinsed and the effluents are discharged into a pair of asphaltic-lined neutralization ponds. This material has a low pH value and caustic is pumped into the ponds and circulated until a pH of 7.0 is reached. It is then pumped to the sewer for disposal.

The plant is designed to produce a water with less than 5 ppm total dissolved solids and not more than 0.02 ppm of silica expressed as SiO_2. A multipoint conductivity recorder measures the conductivity of the output from each anion unit. When the conductivity of the primary anion units exceeds 60 micromhos or if the secondary anion units exceeds 40 micromhos an alarm is sounded. This is the signal for the operator to initiate a regeneration cycle.

Regeneration

Regeneration cycle is initiated manually. All other regeneration operations are completely automatic, being controlled by electrically-operated cycle timers actuating pneumatic controls.

Demineralizer vessels, piping and fittings are rubber lined for corrosion protection. The demineralized-water storage tank is lined with a sprayed coating of polyvinyl chloride.

The water-treating plant has been in service for about a year and is performing as expected. The boiler plant has been in service for ten months, and performance has been entirely satisfactory. THE END

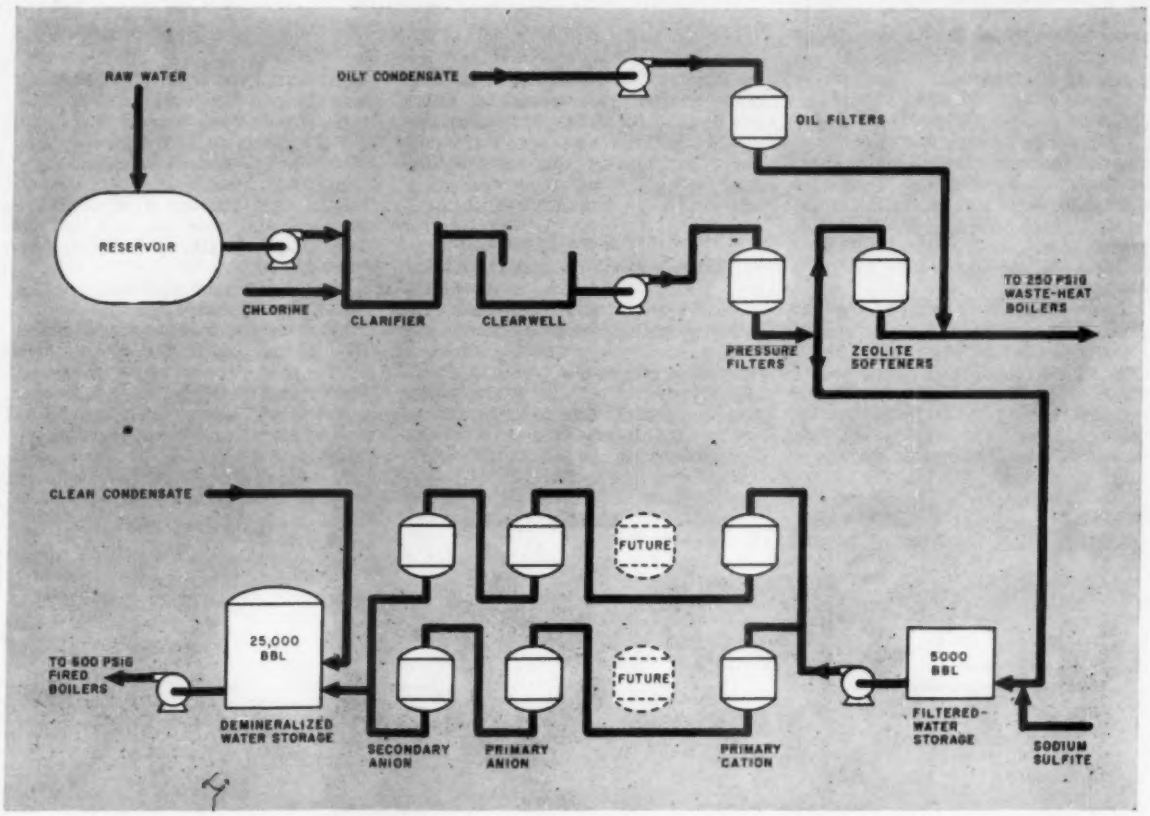


Fig. 5. Complex water clarification, softening and demineralizing system at Tidewater's Avon Refinery. Note that only feedwater for the higher-pressure boilers passes through demineralizer, the balance from softener being otherwise satisfactory

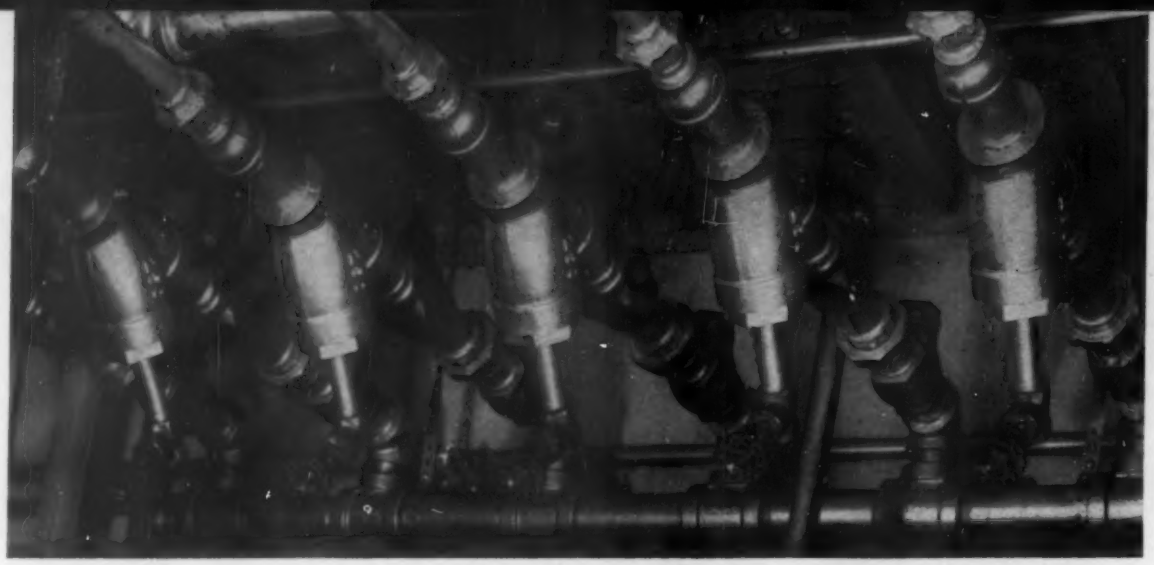


Fig. 1. Typical battery of Y-type strainers, with blow-off connections for cleaning out dirt while the strainers are in use

How to Select and Apply Strainers

Relatively inexpensive in itself, a strainer usually protects equipment having a large purchase and operating cost. So, correct strainer selection is important. By using the hints given in this article you will get better protection from every strainer you use

By J. A. GEIGER*

STRAINERS ARE the "traffic policemen" of modern piping—they allow authorized traffic to pass but stop the undesirables. These undesirables may be dirt, chips, scale, welding dross, packing shreds, sand, gravel, stones, and a variety of other items that somehow can get into piping systems.

Modern strainers are relatively inexpensive, compared to the equipment they protect. For example, consider the strainer used to protect a steam trap. While the trap itself may not cost much more than the strainer, the equipment the trap serves may be worth several thousand dollars, or more.

Should the trap fail to operate because it is clogged with dirt, the function of the equipment it serves may be jeopardized. A forced shutdown of expensive equipment can cause loss of valuable time, production and money. So the strainer is an extremely important link in the chain of industrial and commercial production and service equipment of all kinds.

Strainers Give Protection

Strainers protect a wide variety of key industrial devices and equipment. Typical units protected by modern strainers include steam traps, pressure-reducing valves, control valves, instruments, pumps, unit heaters, meters, etc. Types of industrial equipment, depending on strainers for contamination-free flow, can be numbered in the thousands. Truly, the strainer is one of the modern low-cost keys to safe, dependable operation of many of industry's most important machines.

There are two major classes of modern strainers: temporary and permanent. Under each major classification there are many different types. Each type is designed to serve a particular need. Let's take a look at each of these classes of strainers to see where and how they can best be used in any kind of industrial or commercial plant.

Most temporary strainers are designed for special applications and are not used for extended periods. Typical uses of temporary strainers are for protection of new equipment when it is started for the first time, and existing equipment when it is started after an overhaul or extensive repairs.

A temporary strainer is usually built to remove the larger particles

*Yarnall-Waring Co

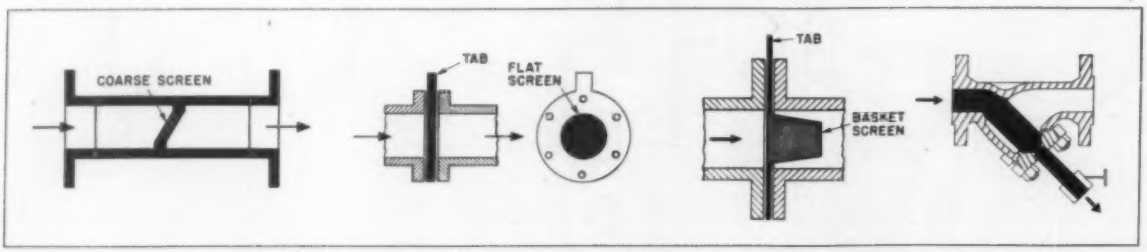


Fig. 2. Four types of temporary strainers for use in new installations or those opened for maintenance or other purposes

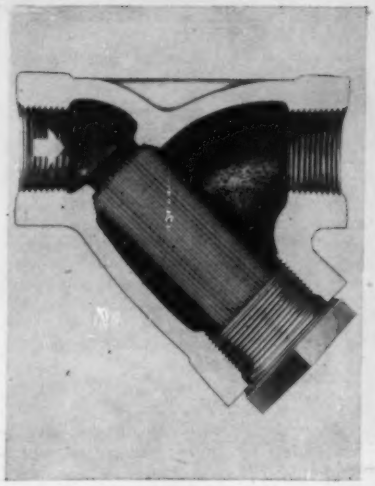


Fig. 3. Y-type strainer is widely used

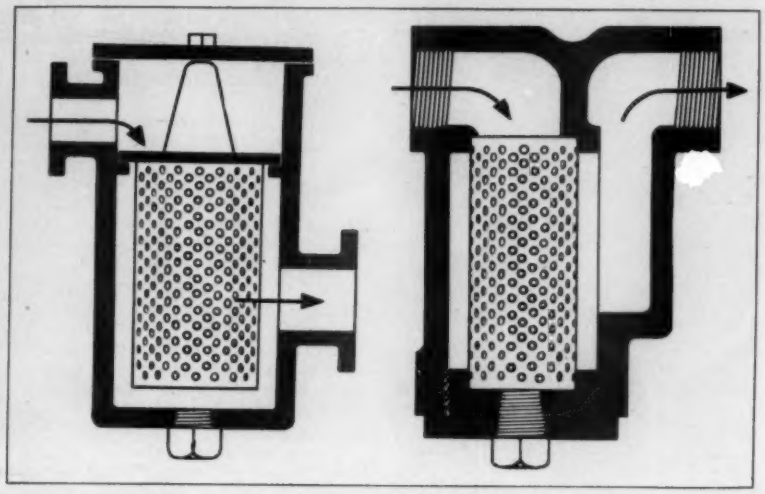


Fig. 4. Important permanent strainers are the S-type, left, and the T-type, righ

from the flow. To secure removal of the smallest particles, a permanent strainer is commonly recommended.

Figure 2a shows a simple temporary strainer constructed from two flanges, a length of pipe, and a coarse screen. This kind of strainer is often used to protect large valves, regulators, meters, pumps and other units from dirt, scale, welding dross, etc, shaken loose from pipes and equipment during construction.

Temporary strainer in Fig. 2b consists of a woven or perforated flat screen supported by a circular metal ring. Placed between two flanges in a pipe, this strainer is relatively easy to install and replace. Another version of this type is shown in Fig. 2c. It has a basket-shaped screen designed to hold a larger quantity of debris.

Both the strainers in Fig. 2b and 2c have a tab or ear extending above the flanges. The tab shows that a temporary strainer is in the pipe and that it should eventually be removed.

A temporary strainer, Fig. 2d, can be built from a permanent strainer. A solid screen without any openings is placed as shown. To rid the strainer of accumulated debris, a blow-off valve is opened at frequent intervals. Once all the dirt has been removed from the piping, the temporary blank screen is removed and the regular woven or perforated screen is installed.

Almost any effective temporary strainer is cheap insurance during initial startup or following a shutdown for repairs. With proper care temporary strainers can be cleaned and stored for your next job. But for low-cost, life-time protection of valuable industrial equipment, you should use a permanent strainer wherever the equipment manufacturer recommends one, or where the flow conditions require one.

Permanent Strainers

Most common permanent strainer is the Y-type, Figs. 1 and 3. This type, with screwed ends, is usually built for pipe sizes from $\frac{1}{4}$ in. to 3 in. The streamlined internal contour of the Y-type strainer allows free flow with minimum pressure drop. Strainers of this type can be installed in any desired position in either vertical or horizontal pipes.

Flowing fluid enters the strainer on the left, Fig. 3, passes through the screen element, and leaves on the right. Any debris is deposited in the screen. The screen can be easily removed for cleaning by loosening the screen cap, or cleaned by adding a blow-off connection, as shown in Fig. 1. Debris thus can be removed while the strainer is in use.

Another permanent strainer is the T-type, Fig. 4b. This type generally has a large screen area; pressure drop through it is only slightly more than through a Y-type strainer.

S-type strainers, Fig. 4a, are another type for permanent installation. This type is usually installed on the suction side of a pump or other equipment. The large screen has ample space to collect pipe scale, gravel, etc.

Where continuous operation is a must and shutdown of fluid lines is not possible, two arrangements may be used. In the first, two single strainers of any permanent type — Y, T, S, etc, — are connected as in Fig. 5. When either strainer becomes clogged, the inlet and outlet valves of the other strainer are opened. Then the

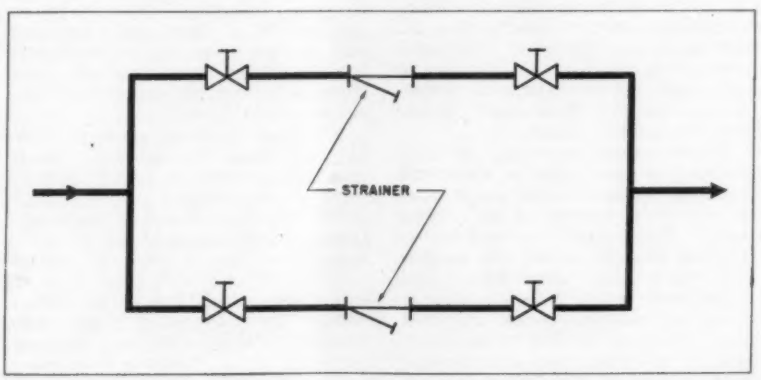


Fig. 5. Where shutdown of fluid lines is not possible, this arrangement or that of Fig. 6 can be used. Here two single strainers of permanent type are connected

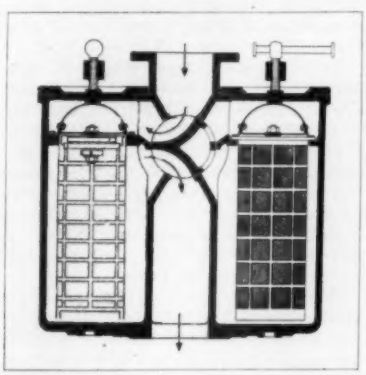


Fig. 6. Here duplex strainer is used. One screen is used while other is cleaned

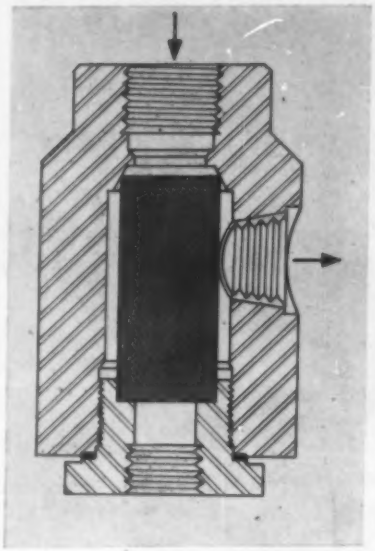


Fig. 7. High-pressure special strainer

inlet and outlet valves of the clogged strainer are closed tightly; the foreign matter then can be removed from the screen without interrupting the flow of the fluid.

In the second arrangement a duplex strainer, Fig. 6, is used. This permanent strainer has two sections with one screen in each. A three-way valve is fitted to the inlet of the strainer. By adjusting the valve handle the flow can be sent through either screen. Thus, while one screen is in use the other screen can go through the cleaning process.

Duplex strainers are popular for use with oil, water, and other liquids. Special magnetic inserts can be supplied for the screens or baskets to remove ferrous particles and chips from the liquid.

There are many special applications where a strainer must be designed to meet a specific or unusual requirement. The right-angle barstock strainer, Fig. 7, has been successfully used in high-pressure service, such as handling helium at 6000 psi and 100 F. One of the advantages of this design is that it can be used in place of an elbow, saving the cost of installing an extra fitting.

Clean dirty screens with a blast of compressed air, if available, or wash the screen in a metal cleaning solution.

To obtain the best results from the strainers in your plant, keep a supply of spare screens and gaskets on hand. Then you can replace dirty screens quickly and clean them when you have time. Be sure to replace the dirty screen with one of the exact mesh and material as the one you removed. The gasket should also be the same.

In the second part of this article, to follow next month, we shall discuss the aspects of special-purpose strainers, such as high-pressure strainers and integral strainers. Then we shall look at the materials used in strainers and examine the various kinds of screens in some detail. Installation and maintenance of strainers will also be discussed. THE END

Turbines for Tomorrow—What Will They Be Like?

By E. H. MILLER* and B. M. CAIN*

A COMPACT and basically simple family of steam turbines, in ratings from 100,000 to 500,000 kw, is available now. With modifications for higher steam conditions and improved steam paths, this family of turbines should cover adequately most applications of the next decade.

In the capacity range of 100,000 to 175,000 kw, the tandem-compound, double-flow reheat turbine, with either 23-in. or 26-in. last-stage buckets, probably will remain the outstanding, popular choice.

To permit the economic extension to the 200,000-kw range of this tandem-compound, double-flow turbine type, a 29-in. last-stage bucket is well along in development. Turbines incorporating this new, longer last-stage bucket will be available in the early sixties.

For the next larger range of ratings, up to 250,000 kw, the additional annulus area provided by three rows of last-stage buckets can be justified.

During the sixties, maximum ratings up to 500,000 kw appear possible with 3600-rpm tandem-compound turbines; however, the maximum economic rating may be closer to 400,000 kw even with four rows of 29-in. last-stage buckets.

An extrapolation of present turbine-generator capability trends indicates that a unit of about 1,000,000 kw may be needed in the late sixties or early seventies. Certainly by that time there will be systems which will be large enough to install a steam turbine generator of this rating without exceeding the traditional relationship of capacity of unit to size of system.

Steam conditions higher than the presently popular 2400 psig, 1050 F are likely to be proven out during the 1960's, and most of our present single-reheat designs already are suitable for 3500 psig, 1000 F. Large, double-reheat turbines with initial 3500-psig pressure and 1050/1050/1050 F temperatures will be going into service shortly in a 3600/3600-rpm, cross-compound, six-flow arrangement.

Advance Cycles

Advance cycles, utilizing the steam turbine and gas turbine together to reduce the cost of power, may become broadly economical during the sixties. A version of this cycle using the gas turbine waste gases in an exhaust-fired boiler offers a four to five per cent gain in heat rate. To make broadest use of this cycle, it must be applicable with coal as the fuel; also, more economical equipment designs must be made available.

In this connection we are seriously studying a new cycle in which the coal is carbonized at low temperature to remove a portion of its volatile matter. This volatile matter becomes the fuel supply for the gas turbine, and the partially devolatized coal, called char, is burned in a conventional exhaust-fired boiler. The technical problems of this cycle appear readily solvable. We are therefore more concerned with the cost of the coal carbonization equipment as it affects the economics of the cycle.

We also can expect the sixties to bring additional atomic energy plants into service. In designing turbines for these plants, we find that many of the anticipated problems already had been solved for earlier low-pressure steam turbine applications. We need only to enlarge this experience to extend it to the higher pressures, higher flows and reactor water chemistry.

Problem of excessive moisture in the turbine can be met in several ways. Our approach has been, in addition to crossover separators, to use ingenious moisture-removal buckets which have proven their effectiveness by years of service. These are buckets with small radial grooves, which trap and remove water by centrifugal action, and which are located in various parts of the turbine as needed.

Satisfactory turbines are now available for use with today's reactors of all types. For water-cooled reactors, we feel that in the future, methods will be developed to obtain superheated steam from nuclear heat which will allow the use of more efficient turbine cycles.

Two important trends have characterized generator developments in matching generator capabilities to those of the driving turbines. First is the continuing trend to larger and larger unit ratings; and second, is the equally continuing trend of increasing the output from a given physical size of generator. Thus, for the sixties, design studies already have been completed for 512,000-kva generators.

*Large Steam Turbine-Generator Dept, General Electric Co. These remarks were made at the 1959 American Power Conference

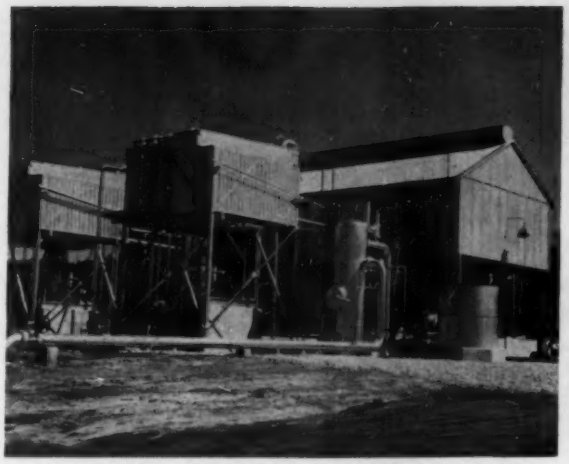


Fig. 1. Oil-field diesel engine plant with ebullient cooling. Vertical tower is separator, cooling tower condenses

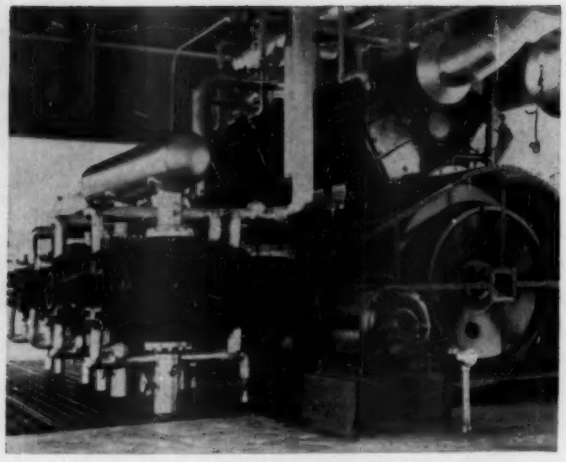


Fig. 2. One of the two 440-hp engines in station at left, able to operate on low-grade fuel due to high temperature

Freeze-Point Depressant Makes Year-Round Ebullient Diesel Cooling Practical

By A. R. CONANT *

CAN CONVENTIONAL internal-combustion engines be converted economically so they can use ebullient cooling? Ebullient cooling is the technical term for cooling by high-temperature water and steam — that is, water that heats up to 212 F or higher and boils within a closed cooling system.

That this can be done effectively on many large stationary internal-combustion engines, is indicated by the data given below.

Recent experience with ebullient cooling for diesel engines on Mississippi River towboats has led to development of a freeze-point depressant that makes high-temperature cooling practical for large stationary engines, keeping them operating at uniform temperatures under all conditions, and improving their operation in several other ways. Here is the way the new coolant was developed.

For these past two winters, a towboat powered by a diesel engine has worked the Mississippi River in the St. Louis area five days a week. On the remaining two days of each week, as well as for several hours each work day, it ties up at a dock in temperatures often well below the freezing point of water.

This towboat uses ebullient cooling for its engines, as do a lot of other Mississippi River towboats.

What has been unusual is that this particular towboat can be docked and shut down indefinitely without regard to what freezing weather might do to its motors. Other towboats with ebullient cooling systems that are shut down in extremely cold weather must have their engines carefully protected by devices such as electric heaters any time they are not in operation. As a result, ebullient cooling for towboats has until recently been considered impractical for use in northern harbors such as New York, Boston and Chicago.

A very basic problem has existed. The water in an engine with an ebullient cooling system heats up to 212 F, or higher, and circulates to a chamber that separates the steam. The water is then returned to the cooling system, while the steam passes through a condenser, is condensed into water once more, and is again returned to the cooling system. It is a completely closed system, and since no water or steam can escape, the engine will not boil dry.

In most cases, there is no real problem so long as the engine is operated in temperatures above the freezing point. But when temperatures drop to freezing or below, the water that is generally used as an engine coolant must have a freeze-point depressant.

Why not antifreeze? A standard antifreeze such as ethylene glycol has not been entirely successful as a freeze-point depressant for ebullient cooling systems because of its inability to form an azeotrope with water. (An azeotrope is a liquid mixture distilling over with a constant composition of a certain ratio.) The water in the engine might be protected by ethylene glycol, but the steam that is separated from the water is also separated from its protection against freezing. As a result, the vapors produced by the boiling mixture contain only water which can freeze in the condensate return line. Thus, the use of electric or oil-fired heaters on motor vessels with ebullient cooling systems is necessary.

Solution needed in this case was as obvious as the problem, although not easy to come by. A new heat-transfer material was required to cool the large, stationary internal-combustion engines, and it had to be one that would form an azeotrope with water.

A product introduced last fall, Dowtherm 209, proved to be such a material. Of many formulations tested, it was found to be the best in giving freeze protection both in the engine and in the condensate return line. Also, its heat-transfer efficiency compares favorably to water. Recommended for use in a 53 per cent (by weight) solution in water, this mixture gives freeze protection down to approximately −45 F. A 60 per cent mixture will provide freeze protection down to −80 F.

Conventional internal-combustion engines can be converted economically so they can use ebullient cooling in about 95 per cent of the cases. Internal design of engines would make such a conversion impossible in the remaining cases. In any event, the manufacturer of a particular

This article is a sequel to Vapor Phase Cooling Systems Turn Waste Heat to Useful Steam, POWER ENGINEERING, May 1958, which described in considerable detail the functioning and advantages of ebullient cooling.

* The Dow Chemical Company

engine will be able to advise whether or not conversion is possible.

What are the advantages that can result from ebullient cooling?

To answer, one must emphasize the point that ebullient cooling keeps an internal combustion engine — or, for that matter, several engines in series — operating at constant and uniform temperature at all times, no matter what the engine speed or load. Circulation in an ebullient cooling system does not start until the coolant reaches the boiling point. Also, if one cylinder is operating at a greater load than the others, that particular area receives the benefit of additional cooling. In many cases, by increasing engine efficiency, usable horsepower is increased substantially.

All of this can be accomplished without pumps to circulate cooling water. This eliminates the necessity of having a water pump, even though it also means a steam separator must be added.

Further savings in parasitic horsepower can be made because the fan horsepower required for an air-cooled condenser is much less than that required for a radiator. It may even be eliminated when a low-pressure steam turbine is used to power the fan.

Automatic control of temperature by the natural law of boiling, and the resultant uniform temperatures in the combustion chamber and throughout the engine, make for several major advantages over conventional engines. For instance, keeping differences in thermal expansion to a minimum means that there is less cylinder wear and lube oil sludging. This naturally decreases maintenance costs while lengthening the life of the engine.

Story is quite different in a conventional engine. Since temperatures are not even, piston-cylinder clearances are not uniform throughout the full stroke. In addition to increasing cylinder wear, some oil gets past the piston rings. This oil becomes carbonized, and efficiency of the engine is decreased. Finally, maintenance costs can only increase because the carbon must be cleaned out periodically.

Saving $70,000

It is also important to note that most of the jacket heat, plus 50 to 60 per cent of exhaust heat, can be recovered when the system is used. Instead of being wasted, this heat can be used for any number of purposes: to heat and air-condition buildings, to refrigerate, to heat chemicals, water and viscous oils, to distill sea water, or for many other process applications.

Recently, engineers at one large production plant in the North estimated the cost of converting fourteen liquid-cooled engines to an ebullient cooling system. They concluded that it would cost approximately $1,800 to convert each engine. Even more interesting was their calculation that approximately $70,000 would be saved in steam costs alone in a year's time.

Since engines that use ebullient cooling can operate at higher temperatures, it follows that they can burn cheaper fuels such as sour natural gases or residual fuel oils that contain sulfur. The engine block is maintained well above the dew point at which corrosive acids can condense. As a result, the acids so formed remain in the gaseous state and are exhausted along with the products of combustion.

In summary, engines with ebullient cooling systems are now practical in the North as well as in the South for several outstanding reasons: cheaper fuels may be used, a boiling liquid gives more uniformity in cooling, what was once waste heat may be utilized, lube oils last longer, and so do engines.

Taken together, these facts mean that conversion to ebullient cooling is now economically worth its while in almost any part of the industrial world. In many cases, in fact, such a conversion can pay for itself in six months.

An example of the role that ebullient cooling may play more frequently in the future can be found in an oil field installation which the Pan American Petroleum Corporation has at Duncan, Oklahoma — an area where sub-freezing temperatures in the winter are not unusual.

Two 440-hp engines, both equipped with ebullient cooling systems and standing side by side outdoors, were used to test an ethylene glycol and alcohol combination and Dowtherm 209 as freeze-point depressants under identical conditions.

Tests were continued throughout the 1957–58 winter, and both ethylene glycol and Dowtherm 209 did their jobs. At the end of the test period, however, operating costs were computed and the latter proved to be more economical. As a result, it is now used in both engines. THE END

Now: Gas Powered Free-Piston Engines For Refrigeration Compressors

AMERICAN GAS Association has recently announced development of a gas-powered free-piston engine to be used as an integral part of a refrigeration compressor.

In essence, the free-piston principle is quite simple and consists of two main functions: 1, the development of power by combustion of natural gas on one end of the piston; and 2, the utilization of this power by refrigerant vapor compression on the opposite end of the piston. Aside from the slight motion of valves, the piston is the only moving part in this engine. The machine, even as reduced to practice as an operating unit, is strikingly simple. To the important assets of competitive first cost and attractive life and dependability, are added highly efficient operation and the absence of mechanical noise. With no bearings, valve gear, or piston-side loading, the silencing problem is reduced to one of muffling the intake and exhaust noises, functions which can be accomplished with existing technology.

This unit has a refrigeration capacity of three tons with a condenser temperature of 110 F and is capable of operating over the full range of air-cooled condenser temperatures. Freon 12 is used as the refrigerant and the compressor is connected to an entirely-conventional condenser, evaporator, and expansion valve.

Fuel is furnished by the use of a direct injection system for dependable starting and operation. A proximity-ignition system, developed during the course of this research, provides ignition without the use of breaker points and with an unusually simple circuit connected to the 110-v household supply.

Compressor cylinder and valves are of conventional design, but a seal must be provided between the compressor cylinder and the upper part of the unit. Refrigerant is retained in the lower end by a special seal developed in the research. It is equivalent to rotary-shaft hermetic.

Starting of the unit is, of course, automatic through use of a small auxiliary compressor which evacuates the lower end of the unit. Unit automatically starts, runs at full power, and stops as required by the demand signal from the house thermostat.

Free piston gas air conditioner stacks up well in the two major areas of competitive comparison, operating cost and first cost. Of particular interest is that high efficiency, as indicated by its performance factor of 0.6 and 0.8 or better, is expected.

With regard to first cost, the free-piston compressor is readily adapted to low cost manufacturing methods. Only 11 major parts or components are required in the compressor assembly, none require high precision. Final product would be completely air-cooled.

Being a vapor compressor, the free-piston gas air conditioner fits into a conventional vapor refrigeration system. A possible over-all design in a dog-house-type installation would be about 32 x 30 x 50 in. and the installation weight would be on the order of 400 lb.

Additional developmental work is necessary to realize the final goals, but American Gas Association is very hopeful that one or more of the manufacturers who witnessed the demonstration will take over and develop the free piston to its fullest potential.

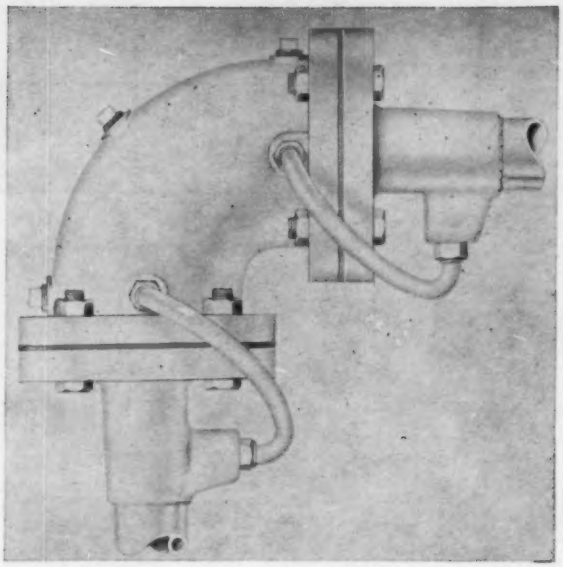


Fig. 1. Unitrace 90 degree ell. Note steam passage as an integral part of pipe. Full line of fittings is available

Boiler water contamination from leaking fuel oil steam tracing systems and high cost of electrical tracing have long plagued engineers. Answer to both problems is in this . .

New Approach to Heat Tracing

LATEST VENTURE of the aluminum industry into the field of power plant equipment is presented here for power designers and plant operators concerned with fuel-oil fired stations. A new product known as Unitrace promises to so simplify heat-tracing of residual fuel oil lines as to render an old headache no longer a problem.

In essence, Unitrace is an integrally extruded aluminum pipe specially designed to combine the fuel oil piping and a steam tracing pipe in one leakproof unit. Cross section of the aluminum pipe, as well as its application to 90-deg bends, is shown in Fig. 1. Unitrace is patented.

This material will find wide application wherever No. 6 or Bunker C fuel oil and fluid coke must be maintained at required temperatures for effective handling and transfer. It holds great promise for nearly all applications where heat-tracing of any kind is indicated, and should be particularly valuable in those areas where extreme cold is a problem.

When installed according to manufacturer's recommended welding procedures, installations should be virtually leakproof. Such an installation is shown in Fig. 2. Unitrace is available in standard pipe sizes from 1 in. through 8 in. A complete line of fittings is available to permit the incorporation of this material into conventional piping systems. Adaptation to existing tanks and piping systems is relatively simple.

Advantages of aluminum in this application are immediately apparent. Lower weight per foot, lower material and installation cost over conventional jacketed, steam-traced or electrically heated lines, and lower fabrication costs are a few. Since aluminum is an excellent conductor of heat, more efficient use of heat transfer media is possible.

Complete data on this novel and effective development is available. If you would like more information on the subject, drop a line to the editors or simply write Unitrace on one of the reader service cards in the back of this issue. THE END

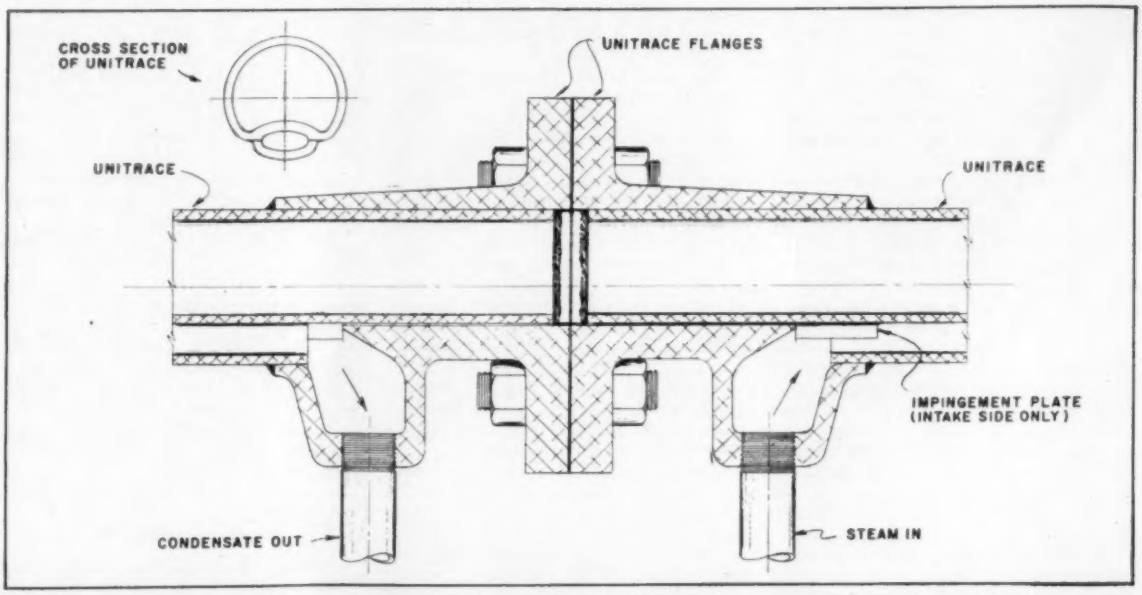


Fig. 2. Diagram showing method of making up a Unitrace flanged joint. Note method of steam entry and condensate exit

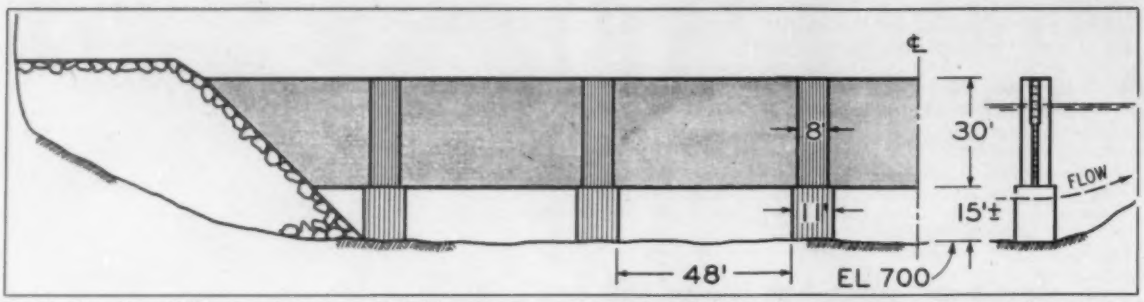


Fig. 1. Elevation of Kingston skimmer wall. Cold water flows through the 48-ft long lower openings plus triangular openings

TVA Tries Skimmer Walls

High head storage reservoirs in the TVA system have created conditions which form induced thermal density underflow currents. To tap these cold underflowing currents for condensing water purposes, TVA has developed intakes which admit only the cold waters

By REX A. ELDER*

WHERE SIGNIFICANT differences in temperature exist between the natural or stored surface waters and the cold incoming waters from a storage reservoir, thermal density underflow currents develop. As more and more reservoirs are added to the chain, these density underflows may tend to be propagated through one reservoir after another in a downstream direction, unless other causes prevent such propagation.

The design of any condensing water intake which is to be located in a reservoir in which density currents occur must take into account such currents if the most economical plant performance is to be achieved. The principal factor, normally of interest, is the provision for tapping the cold water layers; but, in some cases the prevention of recirculation of the heated cooling water discharges may be of importance, and conceivably the prevention of the heated waters from flowing into other intakes could be necessary. Some density flows may carry waste flows which could be detrimental to the successful operation of a plant. In all cases an understanding of the density problem is essential to effect a solution.

Since 1952, TVA has designed and built two condenser water intake structures and assisted in the design of a third intake, each of which permits withdrawal of the cold bottom water from thermally stratified reservoirs. These structures were built at TVA's Kingston and Gallatin steam plants and at the Atomic Energy Commission's Oak Ridge facilities.

At each of these sites it was necessary to develop facilities which would cause the cold underflowing waters to be drawn into the intake pumps. The key facility in each design is an inlet structure which has been termed a "skimmer wall" because it retains or skims off the hot surface water and allows only the cold bottom water to enter the pump chamber, or a canal leading to the pump chamber.

Figure 1 shows the Kingston design, which is typical of all the skimmer wall designs. As can be seen, the cold water flows through five 15-ft high by 48-ft long openings plus two 15-ft triangular openings along the bottom of the structure. The piers for the wall were constructed, in water, by sinking steel caissons and then filling them with concrete. The skimmer wall was then formed by lowering precast, prestressed beams into the slots provided for them in the piers.

The flow areas for these intakes must be made quite large since velocities above about 0.7 fps for an intake of the Kingston dimensions will result in a mixing of the warmer overlying water with the cold density current water. Since comparatively low velocities are involved, no streamlining is required for the openings.

At the time these designs were conceived, very little information was available on the diversion of density underflows through a submerged wall opening. However, TVA had available a large number of field measurements of the flow of thermal density currents, obtained in Watts Bar and Fort Loudoun reservoirs, from which two conclusions were drawn.

The data indicated that, in reservoir channels similar to those at the project sites and for thermal stratifications of the magnitude expected, a relationship exists between the maximum velocity at which density underflow can occur and the depth of the underflow.

Secondly, the data indicated that, at water intakes, the velocity in the intake could be about double the underflow velocity without breaking the stratification and pulling in the warmer overlying waters. Velocities greater than double appeared to break the stratification.

These two field data relationships were used in establishing the preliminary designs for the three projects. The designs were then checked and found to be adequate.

The Oak Ridge skimmer was built on the reservoir bank of the Clinch River arm of Watts Bar reservoir 70 miles below Norris Dam. The pump pit is located directly behind the skimmer wall; thus the water is drawn directly from the passing underflow. It was constructed primarily because of a local artificial stratification condition which is created by a large steam-generated electric plant located 1.7 miles upstream from a cooling tower make-up water inlet. The skimmer wall insures that the coldest of the waters passing the plant will be obtained.

The Gallatin skimmer wall was built on the Old Hickory reservoir bank of the Cumberland River and, like the Oak Ridge intake, draws its water directly from the passing underflow. However, at this site the pumps were placed at the end of a 2600-ft canal, the bottom of which is 16.5 feet above the top of the skimmer wall opening. Thus, after passing through the skimmer wall, the cold water rises and flows through a relatively shallow canal to reach the pumps.

The Kingston installation is con-

*Head, Hydraulic Operations and Tests Section, TVA. This description is taken from a paper presented at the 1959 American Power Conference

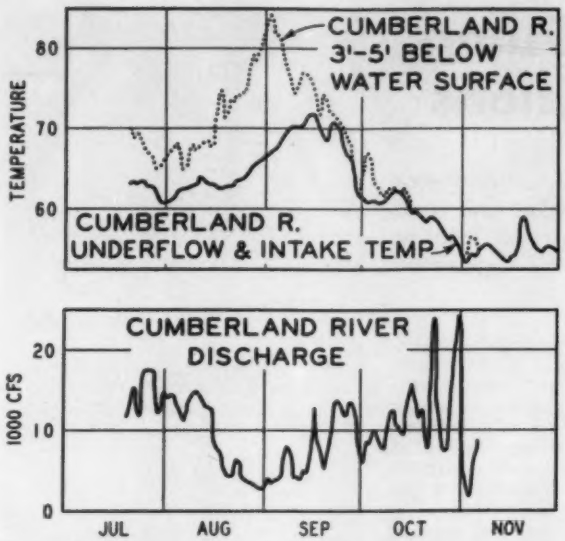


Fig. 2. Effective temperatures, Gallatin skimmer wall, 1957. Wall's value is emphasized during late Aug and early Sept when surface and intake temps differed by as much as 17 F

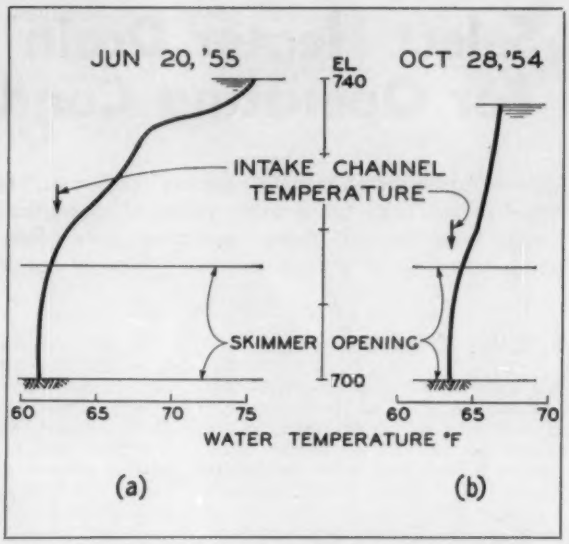


Fig. 3. Temperature reduction effected by Kingston skimmer wall. These profiles were measured immediately upstream from skimmer wall. Only cold waters were passing through wall

siderably more complex than either that at Gallatin or Oak Ridge. The plant is located on the neck of a peninsula formed by the Emory and Clinch River embayments of the Watts Bar reservoir. The problem was one of developing a design which would economically make available, to the pumps, the cold underflowing Clinch River water by bringing it up the Emory River channel and across Swan Pond to the condenser water pump intakes.

The problem was solved by constructing, by means of dikes, an intake canal across the high Swan Pond area. The skimmer wall structure shown in Fig. 1, closes the east end of the canal, except for the series of bottom openings which let in the cold bottom water. An underwater dam located across the Clinch River below the mouth of the Emory River provides underwater storage of the cold underflows and thus allows maximum use of all available underflows.

Performance and Benefits

Only three months of field data are available for the Oak Ridge intake. The data were obtained when the intake was operating at essentially design capacity and showed that the water temperature of the pumped water was identical to the underflow temperature. Hence, the data show that a skimmer wall can be relied upon to operate successfully when the water is being pumped directly from the passing underflow.

The Gallatin system was designed to provide water for five 250,000-kw generating units. To date, only two of the units have been placed in operation; therefore, no data are available on performance at or near capacity. However, the data in Fig. 2 show that the skimmer wall performs perfectly for operations with the two units which are installed.

Field tests made in mid-July, 1957 revealed one interesting factor. At the time of the tests the Cumberland River discharges were fairly high, and as a consequence, the duck-under point, *i.e.*, the upstream point where stratification starts, was in the immediate vicinity of the project. In opposition to conditions that have been observed on the Clinch River, the flow conditions were not clear-cut and no definite duck-under point could be established.

Actually, large cells of warm or cold water existed at random over a mile or more of the river length. The warm water cells were up to 20 or 25 feet in depth. Since the top of the skimmer wall opening was 31 feet below the surface, no detrimental action occurred. It would appear, however, that operation in the vicinity of the duck-under point may be more difficult to predict than where definitely stratified flow exists.

The skimmer wall and Swan Pond dikes were completed at Kingston in October, 1954, and the underwater dam was constructed during the winter of 1955–56. Performance data are available, therefore, on the operation of the system with and without the underwater dam.

The efficacy of the skimmer can be shown by the two vertical temperature profiles of Fig. 3 which are typical for the widely varying degrees of stratification under which the wall has satisfactorily operated.

In June, the incoming solar radiation heats the water flowing in the Swan Pond canal and can raise the temperature by as much as one degree F. If this is taken into account, it is apparent from Fig. 3 (a) that only the cold bottom waters were passing through the skimmer wall opening. It is equally apparent from Fig. 3 (b) that at very small density differences, only the coldest bottom waters are drawn through the wall.

Economic Results

As a part of the economic justification of the Kingston works, an evaluation was made of the financial benefits that result from the diversion structures. The benefits were based wholly upon the purchase cost of the additional coal (not including costs for handling and processing through the plant) that would have to be burned if the plant produced nine-tenths' rated capability while using condensing water at the temperature available without the walls.

In actual operation, the measured temperature reductions show that the savings realized from the skimmer wall and dikes in 1955 amounted to $105,000. In 1956, with the underwater dam in place, the savings amounted to $155,000. If the costs for handling and processing coal through the plant were included — which is reasonable to do — then the savings realized would be increased by about 20 per cent. Furthermore, if the costs were evaluated upon the basis of additional energy sales, the benefits would be still greater.

The construction costs of the skimmer wall were $251,000; of the dike system, $191,000; and of the underwater dam, $31,000. These total $473,000 for all the works. Considering the year 1956 as representative of the annual benefits from the system, then, in the short course of three years, the total benefits are equal to the entire cost. Thus, the skimmer and underwater dam are very profitable additions to the steam plant facilities. THE END

Select Heater Drain Pump For Operating Conditions

Operating under extremely rigorous conditions, real test of heater drain pumps may come after years of operation when unit is no longer base-loaded. Swing operation quite often proves fatal to pump impellers if pumps are not properly conditions-engineered

By T. W. EDWARDS*

WITH EVER-INCREASING attention given to improving heat rate in modern high-pressure steam power plants, use of heater drain pumps is becoming more frequently considered. It is very simple to prove on paper that a heater drain pump, in spite of its horsepower requirements, does preserve to the cycle heat otherwise rejected in the condenser. On the other hand, intangibles of added cycle complication and potential operating problems are difficult, if not impossible, to reduce to Btu or equivalent dollars.

There is perhaps no power plant pumping service more severe than that of the heater drain pump. It is subject to wide variations in operating conditions and frequently exposed to highly unstable temperature-pressure conditions.

In many cycles the heater drain pump is, in effect, a young boiler feed pump insofar as temperature and pressure are concerned. In addition, it is subject to all the transient suction-side operating conditions that can result from load swings.

Since some of the operating characteristics of heater drain pump service are similar to condenser hot well service, the two are frequently and erroneously related to each other. This could not be further in error, especially in the case of high temperature-pressure applications. Rather, heater drain pumps should be compared to boiler feed pumps, and the same care given in their application.

In general, two basic types of heater drain pumps are employed. Probably the most reliable type for this service is the horizontal shaft design employing either over-hung impellers or center-mounted impellers, as in Fig. 4. In either case, oil-lubricated bearings are provided.

Where special conditions dictate a departure from the reliable pump mentioned above, vertical can-type pumps, Fig. 1, are frequently used. This would be the case where, for irrevocable reasons, available net-positive-suction-head is at a premium.

While vertical can-type pumps are relatively satisfactory for low-pressure, low-temperature heater drain pump service, operators should not consider them the equivalent, in reliability or ease of maintenance, of horizontal oil-lubricated pumps.

In the pressure-temperature zone of a modern steam power plant, vertical can-type heater drain pumps should definitely be avoided. In heater drain service, danger of transient operation and resulting flashing in bearing areas is very real. Resultant loss of lubrication can produce unsatisfactory bearing life.

Unlike condenser hot well pumps, "cavitation control" is seldom if ever used in heater drain pumps. Reason for this is simple: in hotwell service where low operating speeds are dictated by net-positive-suction-head availability and total heads to be developed, minimum NPSH required values are possible. Therefore, energy level in hot well service is relatively low.

Assume, for example, a condensate pump requiring 3 ft of NPSH while pumping 100 lb of water per minute. Energy level here is 300 ft-lb per minute. On the other hand, a heater drain pump operating necessarily at 3600 rpm because of the required developed head, might take 12 ft of NPSH while pumping the same 100 lb water per minute. Energy level under these conditions would be 1200 ft-lb per minute. Resultant increase in energy level produces an increase in the destructive effect of cavitation.

How Capacity Is Controlled

In the former case of the hot well pump, the normal bronze impeller might last a great many years. In the latter case of the heater drain pump, even a chrome steel impeller might have most unsatisfactory life. In addition, adverse effects of high vapor pressure associated with high pressure heater drain pumps precludes so-called cavitation control.

For these reasons, capacity is controlled almost universally by a throttle valve located in the pump discharge line, Fig. 3. Throttle valve is actuated by heater hot well level. In this manner, relatively constant NPSH is made available to the heater drain pump, always in excess of that required under full-load conditions.

Unlike condenser hot well pumps, high suction volume is rarely automatically available to the heater drain pump. Therefore, sensitivity of the throttle control is very critical and care must be exercised to prevent the heater drain pump from

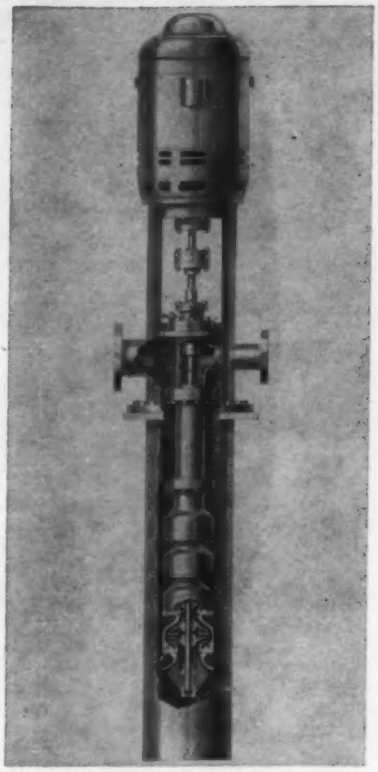


Fig. 1. Can-type pumps like this one do best if used in low-pressure service

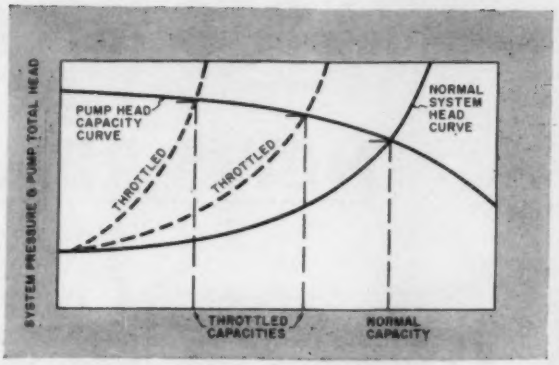
pumping the heater hot well dry. If this occurs, the pump automatically reverts, if only instantaneously, to cavitation control with all of its destructive effects. Over a period of time such a pump might well have unsatisfactory life.

Since heater drain pumps, like hot well pumps, handle condensate at or near to its saturation temperature and pressure, it is necessary that they be properly vented. Vent lines should be of ample size and run directly to the steam space in the heater. Care should be taken to avoid high or low spots in the vent line.

As in the case of boiler feed pumps, where high power input at zero flow can create rapid temperature rise, so also must heater drain pumps be protected by thermal by-pass. Rule of thumb which governs determination of by-pass flow in boiler feed pumps (usually per 100 hp at shutoff) applies equally well to heater drain pumps. In view of the relatively low horsepower involved, it is frequently found economical to provide for continuous by-pass flow rather than pay the high price involved in automatic flow control equipment.

Heater drain pumps can also suffer from the effects of transient operating conditions during violent load changes. For purposes of studying the effects of transient operating con-

*Manager, Boiler Feed Pump Section, Harrison Pump Div of Worthington Corp



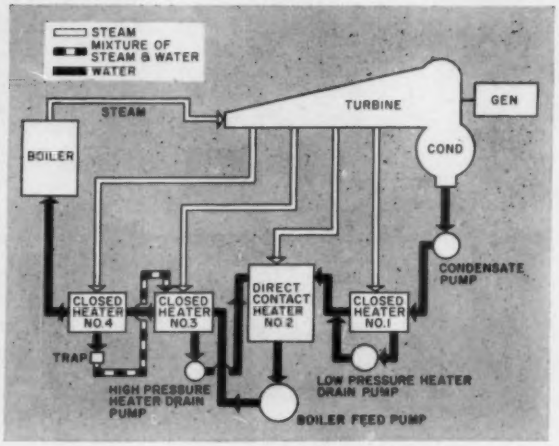


Fig. 2, above, shows how pump head curve looks with pump regulated by throttle valve in discharge line. Fig. 3, right, shows line diagram of a typical heater drain pump layout

ditions, a heater drain pump may be considered as a boiler feed pump taking its suction from an open heater. After all, the hot well of the heater is exposed directly to bleed steam conditions. Therefore, in the event of a violent load reduction it is possible for the heater hot well to flash and create a severe operating condition for the pump.

Feed Pump Conditions Prevail

Same basic laws apply in the prevention of this phenomenon and the minimizing of its destructive effects as are used in the case of high pressure boiler feed pumps: 1. Suction piping should be as small and direct as possible, consistent with reasonable friction losses; 2. Adequate NPSH margin must be available; 3. Heater drain pump should be of rugged design, consistent with the intended service. Under these severe operating conditions, the horizontal oil-lubricated pump is especially superior to the vertical can-type pump.

Since many heater drain pumps, and especially those in the lower pressure end of the feedwater cycle, are subject to suction pressures both above and below atmospheric pressures during cycle swings, Fig. 2, stuffing box operation must be carefully watched. Studies of oxygen content in boiler feedwater at various points in the cycle frequently show the adverse effect of leaky heater drain pump stuffing boxes.

Gross sealing must be employed to preclude air leakage in the case of idle pumps. If at all possible, it is probably better to eliminate heater drain pumps at points in the cycle subject to operation at less than atmospheric pressure. Heaters under these conditions might better be drained by cascading directly to the condenser. The small heat loss thus incurred can frequently be more than charged off against the reduction in oxygen which can result in the low-pressure end of the feedwater cycle if heater drain pumps are used.

Since many of the items of grief that can befall the heater drain pump are a function of load swings, inadequacies in design and control may not evidence themselves during early stages of station operation. Later, after several years of operation when more efficient stations are brought on the line, load swings become more usual. It is under these conditions that transient operation and vacuum suction conditions become the order of the day. Then, the adequacy of original design can be more easily judged. Since a station is the newest in the system for only a short time, design considerations should account for heater drain pump operation under widely varying loads. THE END

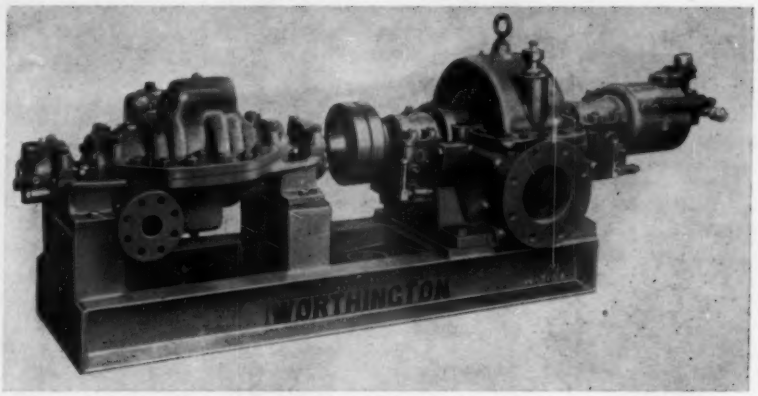


Fig. 4. Horizontal-shaft pumps with center mounted impellers, such as the one shown here, are generally considered more reliable than are can-type pumps for applications where conditions of high pressure and temperature obtain

Industrial Power Plant Accounting Reprints Available

We are making reprints containing the four important articles on Industrial Power Plant Accounting, by John S. Cole, published in the past four issues of POWER ENGINEERING. These cover:

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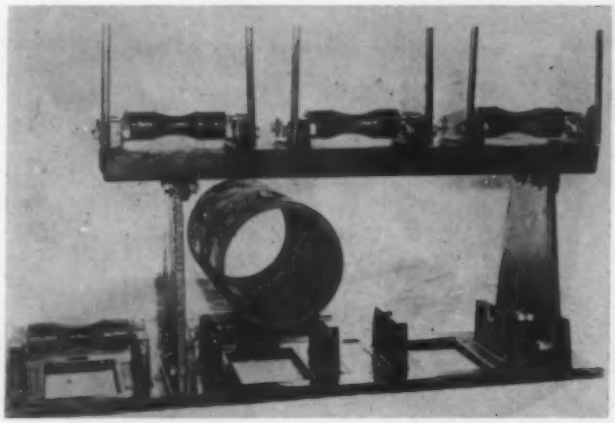
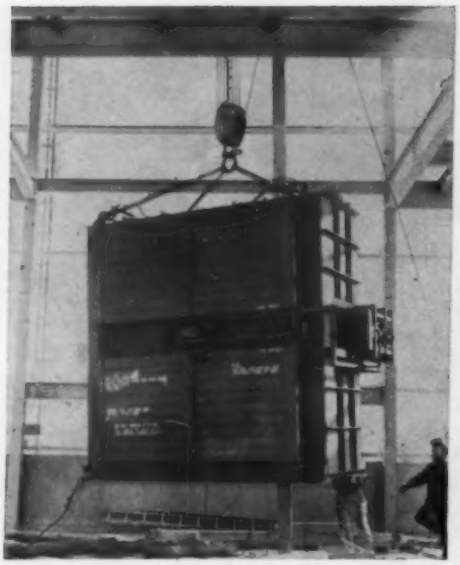
NEWS REEL



100,000 lb of ductile iron castings are being used by ConEd in laying 69-kv cables across New York's Queensboro Bridge. The feeder cables are housed in 8-in. pipes which rest on ductile iron supports designed to resist vibrations caused by constant traffic flow on bridge. Each assembly supports six pipes

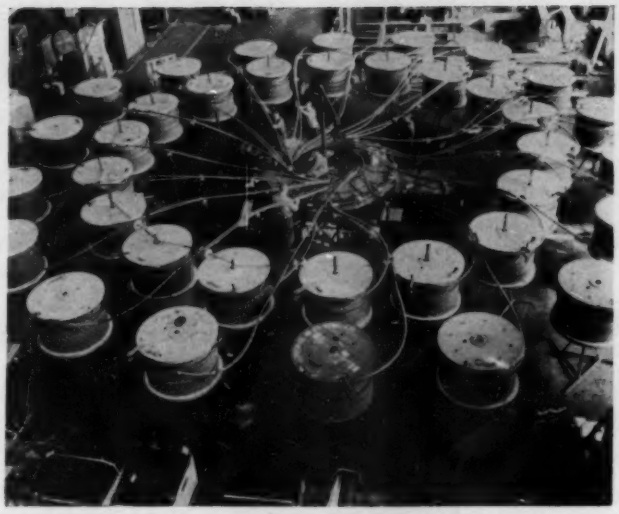


▲

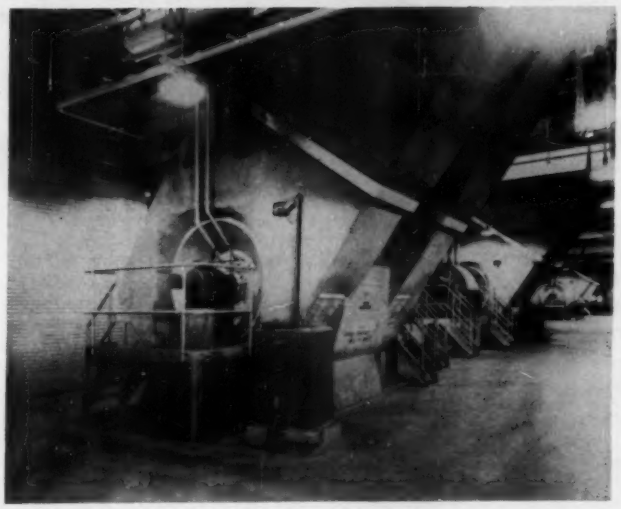
Swinging 'em into place. Factory-assembled preheater (left) made by Air Preheater Corp goes into new power station in Braintree, Mass. It's being used on a 130,000-lb/hr boiler. 1250-hp synchronous motor (right) goes into the new Thos. H. Allen Station (below). It's one of six that drive the pumps for condenser cooling water

Thos. H. Allen Generating Station in Memphis is said to be the largest steam power station ever authorized at one time by any municipality. Burns & Roe designed it, for 750,000-kw total nameplate capacity from three tandem-compound turbine generators. Plant is sheathed in aluminum panels from Alcoa

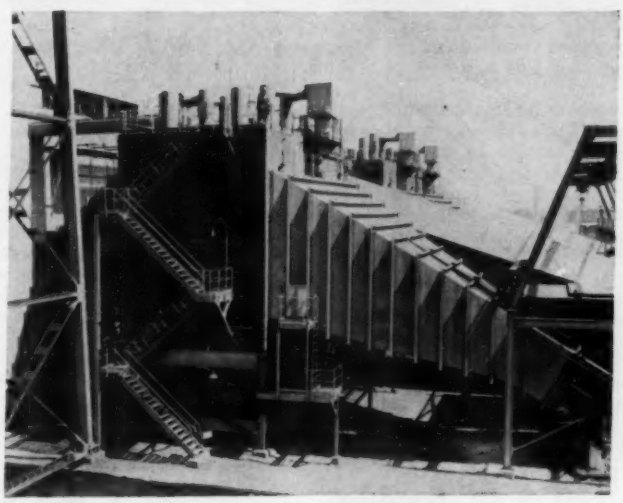
NEWS REEL



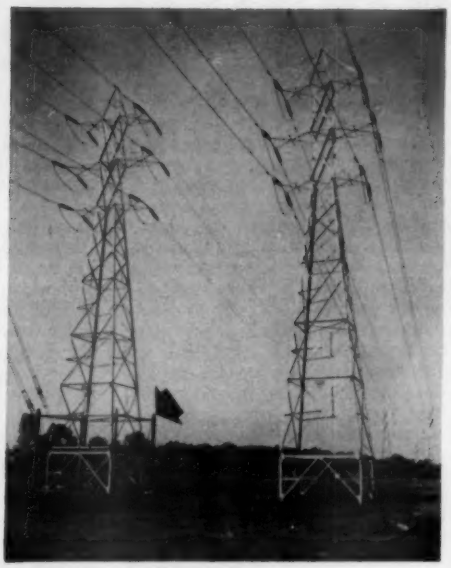
Grand right and left from 36 reels of heavy copper cable as circular platform in center slowly revolves. This view was taken in a GE plant as workmen wound a huge induction coil to store energy for an Air Force hypersonic wind tunnel. Finished coil will contain about six miles of cable and weigh 60 tons



Under the ID fans in the Ohio Valley Electric Corp's Kyger Creek Station. Installed in a bank of five double units, these Westinghouse Sturtevant fans are capable of moving 2,500,000 cfm. Kyger Creek provides the power for the Atomic Energy Commission's gaseous diffusion project at Portsmouth, Ohio



87.2 per cent of the dust is removed from the gases of U. S. Steel's new sinter plant at Gary, Ind, before emission from the stack. Job is done by three Koppers electrostatic precipitators (this one and two visible just beyond). Each unit is designed to clean 360,000 cfm, is 43½ ft wide, 31 ft high and 22½ ft deep



Hoisting device (left) enables Cleveland Electric to jack up towers for height extensions to be added, with minimum of service disruption. Extra height of from 10 to 30 ft was needed in reconductoring lines with much larger conductors. Blaw-Knox made the extensions

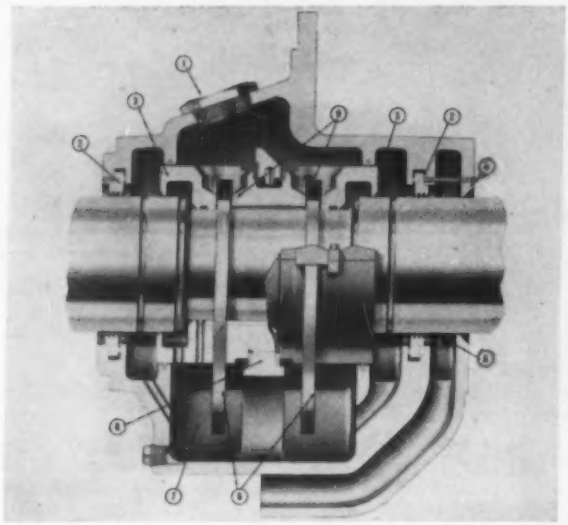


Fig. 1. Horizontal-sleeve-bearing section, 1200 rpm or less

1, Sight glass; 2, Annular labyrinth seals; 3, Seals integral with bushing; 4, Seal integral with capsule; 5, Pressure vent; 6 Oil rings; 7 ,Reservoir; 8 Self-aligning seat; 9, Shrouds

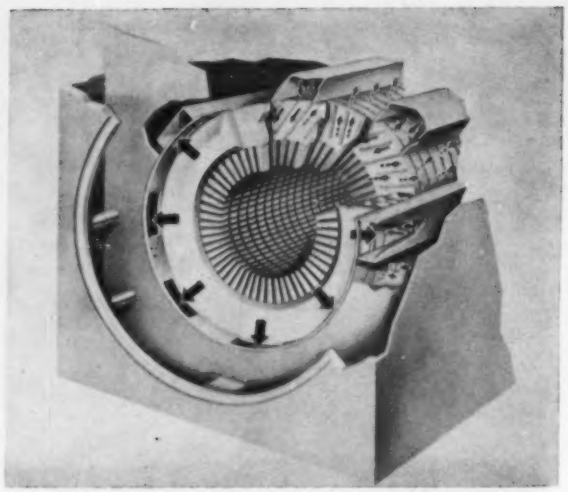


Fig. 2. Section through two-pole motor showing spiral ventilation. Solid arrows indicate cool incoming air before entering the laminations. Dotted arrows indicate warm exhaust

How to Choose and Use Your

In this, the first part of a three-part article, the author outlines all of the principal electrical and mechanical factors to be considered in the design of electric motors for power plant uses, and describes their relation to choice and application of motors

By R. J. POTTS*

ELECTRIC MOTORS have seen a vast change since the early Edison Dynamo. Not only has the electric motor been constantly improved in mechanical and electrical design, but it is the most economical method of driving a multitude of different loads in various applications.

The electric motor is reaching into areas of applications where only recently it was considered impractical. Cumbersome and costly enclosures are no longer needed. Electrical operating efficiencies are better. Across-the-line starting has become commonplace since design improvements lowered inrush currents. Quieter motors requiring less maintenance and having a higher degree of reliability are characteristic of today's power-plant motors.

Power engineers are acutely interested in the new trends and developments of motors since they are responsible for motors, not only after their installation, but also while on the design board. Through the close coöperation between motor manufacturer and the power engineer, the motor that is best for each specific application is conceived.

It is important, therefore, that the basic approaches and successful experiences of applying power-plant motors be constantly reviewed and evaluated. Out of the evaluation will come new standards and more modern motor designs due to the continual evolution of new motor developments.

Let us analyze the major auxiliary power-plant motors with respect to pertinent electrical and mechanical considerations of motor application. During this study, we can observe the more important trends in motor design and see how this will benefit overall plant economy.

It would be well, however, before discussing specific applications of various types of motors to various auxiliary functions, to review the pertinent design considerations, both electrical and mechanical.

Electrical Design

Power engineers are acutely aware that as the voltage at the terminals of an induction motor decreases, the torque output of the motor varies as the square of that value. From Fig. 3, we see that a 70 per cent voltage produces about 49 per cent normal torque.

A drop of this nature can happen when a fault has occurred on the system. Upon reclosure, all of the electric motors beginning to reaccelerate can produce a low motor-bus voltage. The auxiliary motors should be capable of operating successfully for one minute with rated full-load torque at a voltage of 70 per cent.

At reduced voltage, the motor must necessarily have enough breakdown voltage so that the load torque does not exceed the motor torque at any time. From Table I, it is shown that as the one-minute operation is necessitated for increasingly-greater voltage drops, the actual breakdown torque of the machine increases. Of course, a premium must be paid for the higher breakdown torque and the larger machine. The 70 per cent voltage condition is a practical, one-minute operation point.

In bus reclosures, the problem exists of how fast should you reclose. If the residual voltage being generated by the motor bus is 180 deg out-of-phase with the source voltage, a resultant voltage of twice normal is seen by the motor. Transient torques, 20 times normal torque, have been recorded on motors.

For this reason, a safe time for reclosure would be when the residual voltage of the motor bus drops to within 25 per cent of its original value. This would eliminate the high torques when reclosing out-of-phase.

It is true that by waiting too long for reclosure, acceleration problems would be more difficult (Fig. 5), and

* Application Engineer, Motor and Generator Department, Allis-Chalmers Manufacturing Co

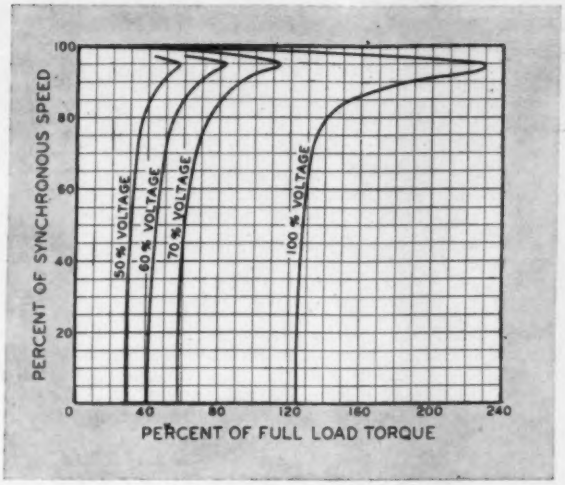


Fig. 3. Variation of available shaft torque with lowering of motor's terminal voltage, as shown in this graph, approximates the square of the per cent of the full line voltage

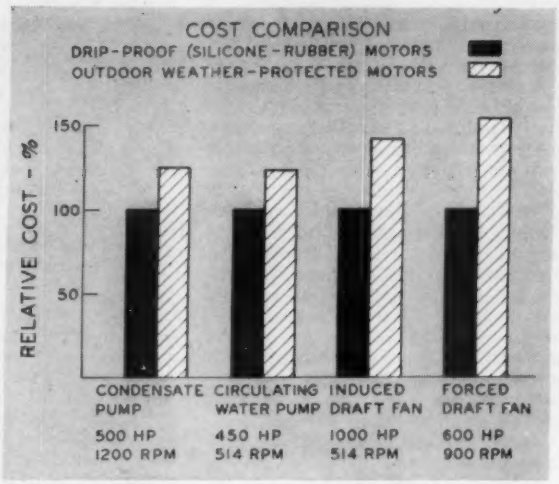


Fig. 4. Comparison of cost of drip-proof with conventional outdoor motors reveals the substantial variation in favor of the former, which also usually has a higher service factor

Power Plant Motors Properly

the low voltage due to acceleration currents would persist longer. The optimum solution would be to have instantaneous reclosing in which the residual voltage would be in phase with the applied voltage. A necessary feature of all power plant motors is adequate and substantial bracing on the stator coils. The shock of reclosing places on a motor the most severe mechanical stress it will ever receive.

Adequate protective devices, such as stator-temperature detectors, thermal-overload elements, differential relays for fault protection, surge-voltage protection, and proper stalled-rotor protection, represent good operating policy. Enforced starting restrictions for fan motors are a necessity.

Continuous overloads on motors should be carefully watched. It is natural to expect, even though not guaranteed, a small percentage of overload from a motor beyond the manufacturer's nameplate service factor. This can be abused, however, and excessive overloads will reduce motor life to a fraction of its normal use.

Make sure that service factors on the nameplates are observed. Even if the motor could maintain a continuous 50 per cent overload from the insulation standpoint, the excessive rotor losses, the differential expansions of the different machine fits, the overload on the bearings and coupling, etc, would be limiting factors. It is advisable to consult with the manufacturer in any case where operation beyond the manufacturer's limit is being contemplated.

Table I. Showing the definite relation of breakdown torque to momentary (one-minute) reduced-voltage operation

Breakdown Torque	Momentary Operation with Rated Full-Load Torque at Reduced Voltage of
Standard	70%
250%	65%
300%	60%
350%	55%
400%	50%
500%	45%
600%	42%
700%	40%

Mechanical Considerations

All motors should be braced for full-voltage across-the-line starting. This is necessary for the prevention of copper movement and copper fatigue during starting operations. As mentioned before, adequate mechanical protection is required during rapid reclosures and bus transfers.

All rotor fans should be constructed to combat fan breakage caused by centrifugal forces. One practical construction is a U-shaped radial fan. This construction provides double support of the fan on the spider and prevents loosening.

An important mechanical consideration in motor applications is proper bearing design and ease of maintenance. A good method of adequate bearing inspection is using a single large Plexiglas port (Fig. 1) that allows oil ring observation without exposing the bearing journal and oil reservoir to ambient dust and foreign material. By individually splitting the end shield, bearing capsule, and bearing bushing, it is not necessary to expose the bearing when the top half of the motor end shield is removed during inspection of the stator and rotor.

Consideration must be given sleeve-bearing end float and the associated maximum float of the coupling (limited end-float coupling). End float of motors should be per Table II. Motors and their flexible couplings should be so arranged as to prevent thrust from being transmitted to the motor bearings and damaging them. Operating experience on motors has shown that sufficient thrust to damage motor bearings may be transmitted from a flexible coupling of normal design.

Difference between the end float of the rotor and the coupling, as shown in Table II, allows for expansion and contraction in the driven equipment, for clearance in the driven-machine thrust bearing, for end-wise movement in the coupling, and for assembly.

To facilitate installation, the motor should have a marking plate which indicates the magnetic center of the motor with reference to some machined surface of the motor exterior. Motors should be adjusted by the manufacturer so that the operating center of the bearing lines up with the magnetic center of the bearing. Bushings employing a single seat are proportioned to provide a self-aligning action. Supported on a shoulder of the capsule, the bushing can be

ocated axially by means of shims (located at the seat) to provide motor float adjustment, as shown in Fig. 1.

A common practice is the installation of bearing temperature relays or thermocouples. In installing the bearing thermocouples, a proved method is to allow the oil draining from the shaft to flow through oil-return holes in which the thermocouples are embedded. In this manner, the lubricating oil actually flows around the thermocouple, and the true oil temperature is faithfully reported. For best results, the thermocouples should be mounted as close to the babbitt as possible. Temperatures of 90 C are satisfactory operating temperatures. A bearing-temperature limit of 96 C is practical.

As pointed out in boiler-feed-pump applications, noise generation can be a serious problem (this excludes the very common beat effect, found in two-pole motors, which is produced at two times slip frequency and is caused by inherent magnetic radial forces, shaft keyways, slight unevenness in the airgaps, etc). Spiral ventilation helped reduce noise by the circulation of the air around the stator laminations first and then in from the back side of the laminations. See Fig. 2.

Design trend has been to eliminate the vents in the rotor which lead to noise. By decreasing the amount of core space above the rotor rods, noise has been minimized. Fan area noise can be greatly reduced. This source of noise on motors is minimized if the air baffles are of a smooth construction. By keeping the inlet air velocity at a minimum, which means larger fan inlet areas, noise can be reduced.

A definite trend in noise elimination on high-speed motors has been to place the air intake and discharge away from the generating sources of noise themselves. With the air intake and discharge near the top of high-speed motors, the generated noise of the rotor has a longer path to travel and is easier to muffle out. The air intake at the top of the high-speed motors also has the advantage of keeping foreign materials from the floor of the power plant from being drawn into the motor.

In certain instances, noise reduction can be enhanced by special baffling placed inside the motor yoke and by special sound-absorbing sections placed integral with the discharge openings. The overall trend of power plant auxiliary motors is definitely towards quieter operation.

It is important that a good maintenance program be carried out. The most modern improvements in motors still have to be backed up by periodic and effective maintenance. All filters should be cleaned or replaced regularly. Proper lubricants should be used in the bearings, and in the case of antifriction bearings, grease fittings should be supplied with screw caps instead of grease holes which permit uncontrolled greasing. A history should be kept on all motors for future reference.

Table II. Tabulation of limitations applicable to clearances in motor bearings

Motor Horsepower	Synchronous Speed of Motor, Rpm	Minimum Motor Rotor End Float, Inch	Maximum Coupling End Float,* Inch
250 to 450, incl	1800 and below	1/4	3/32
250 to 450, incl	3600 and 3000	1/2	3/16
500 and higher	All speeds	1/2	3/16

* Couplings with elastic axial centering forces are usually satisfactory without these precautions.

Silicone Rubber

Through the years of motor development the most effective output per size of package has always been the goal. The output of an induction motor is a function of the length of the iron of the machine and the square of the diameter. For many years designers knew that smaller motors than those being produced could produce the necessary output required.

Unfortunately, the cooling of a motor is a function of length as well as diameter — not diameter squared. So even though the design could stop at a certain frame size, the frame had to increase for the reason of cooling the motor sufficiently.

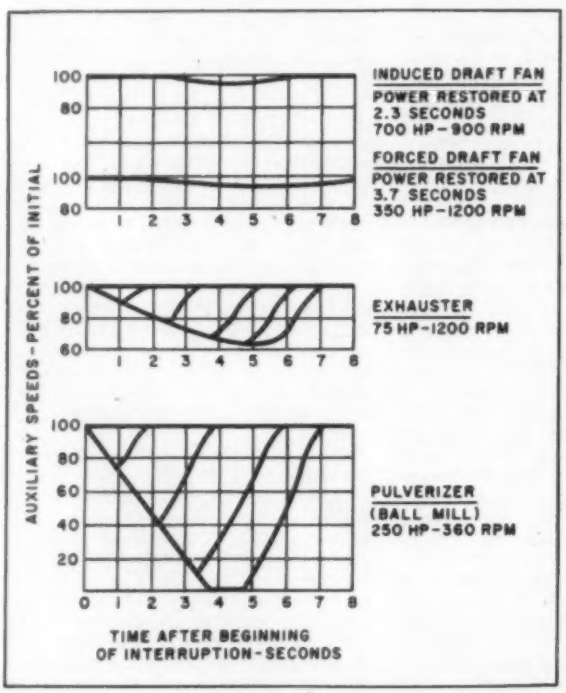


Fig. 5. Speed variations as caused by power interruptions

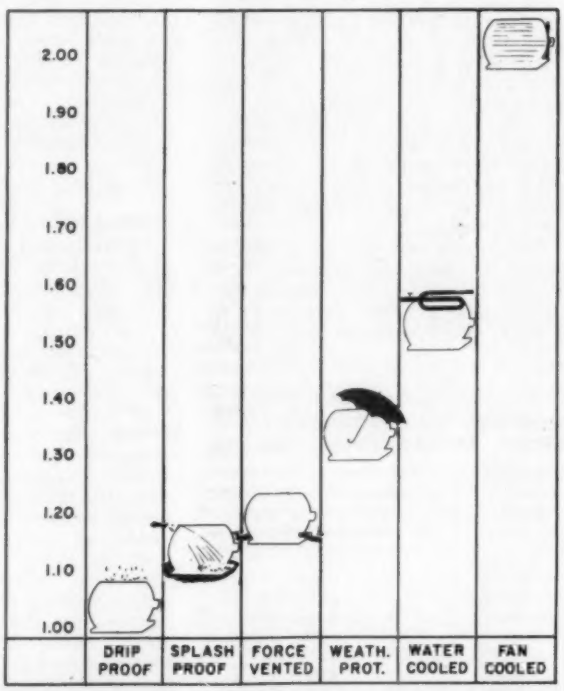


Fig. 6. Motor cost in dollars compared to type of enclosure

Through the advent of better insulations, the motor engineer can now stop at the frame size which will give him the required horsepower output. Even though the machines will run slightly warmer, the insulations are compatible with the temperature rise. The new silicone insulations not only permit smaller frame sizes but increase motor performance, minimize costly insulation breakdowns, and reduce initial costs.

An eastern utility made a revealing discovery when they found out that they could use open motors with silicone-rubber insulation in place of weather-protected motors. Appreciable savings were effected per motor without sacrifice of reliability. (See Fig. 4.) The motors also were capable of working within a substantial service factor. Figure 6 shows a relative comparison of all motor enclosures. Through the application of silicone-rubber on the stator of induction motors, the more costly enclosures can be removed with adequate protection of the motor being retained.

An analysis of a 3600-rpm boiler-feed-pump motor will help in pointing out some of the hidden benefits of this insulation and smaller frame size. When the motor is placed on the line, the accelerating time of the motor and the boiler feed pump will be cut one-third. This is due to the fact that the Wk^2 value of the motor rotor has been cut anywhere from one-third to one-half because of its smaller frame.

Because the motor rotor contributes more inertia effect than the boiler feed pump does, the overall inertia will decrease. With the resulting faster acceleration, the high inrush currents are not with the motor as long, and voltage stability on the system is greater while the motor enjoys a longer life due to less heating of the stator and rotor.

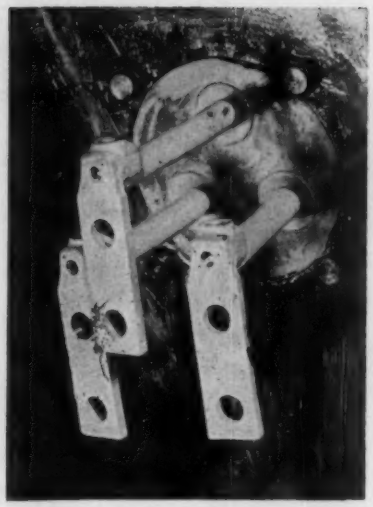


Fig. 7. Stator-lead termination through rubber grommets and epoxy-wood

Fast acceleration is also advantageous with respect to high-speed bus transfer. The smaller rotor is easier to balance and also results in less total rotor weight per bearing of the motor. The overall machine has reduced weight and its floor space is more compact. Cleaning of the coils is greatly simplified because water can be used as a cleaning agent. A rubber-grommeted yoke-threat (Fig. 7) can be utilized in protecting leads from abusive bending and fatigue.

Conclusions

The modern motor is a highly-reliable prime mover. Through new dynamic insulations, longer-wearing bearings, more peaceful-sounding motors, and greater reliability, power engineering is getting greater insurance of safe, continual motor performance. At no time, however, must the team of power engineer and motor engineer relax in its investigations of finding better ways of building motors, applying motors, and protecting motors. Through the interchange of methods and experiences, the motor becomes increasingly better.

Editor's note: In the two subsequent articles the author will discuss in detail principles of the design and application of motors for the major power plant auxiliaries. The second article will be an extensive treatment of boiler feed pump motors, including such aspects as critical speed, rotor construction, cooling, noise reduction, and lubrication.

The third article will take up the motors of circulating water pumps, condensate pumps, induced and forced draft fans (including speed control), and mill and crusher motors. THE END

Plan Ahead for Your Next Industrial Turbine

DURING the post-World War II period, American industry has installed approximately 5,000,000 kw of steam turbine generators of the process type. This fact was called to attention of the American Power Conference recently by M. E. Ferson, Manager of Industrial Sales of General Electric's Medium Steam Turbine Division.

Above figure does not include the large straight-condensing-type units such as have been installed in some of the steel and aluminum plants, since these units have in general followed electric-utility practice.

Added investment required for by-product power generation is generally only a fraction of that required to satisfy basic plant requirements by other methods. Consider a plant which requires large amounts of low-pressure steam. Minimum investment requires boiler capacity at the process-pressure level, fuel-handling equipment, steam-distribution systems, incoming-power sub-stations and electrical-distribution equipment to handle purchased power.

For by-product power generation, the plant cost is increased only by the incremental cost of higher-pressure and temperature boiler equipment and the turbine-generator equipment. Part of this added investment is offset by eliminating, or greatly reducing, the size of substation required to handle incoming power.

Realization of maximum operating economies requires forward planning on the part of industrial power engineers. Such planning should include examination of various types of drives for mechanical equipment such as steam turbines, combustion gas turbines, electric motors and the like. It also involves simultaneous evaluation of the plant's entire electrical system.

In projecting future plant requirements it is important to consider the effects of continued automation and increased productivity in a particular industry. In general, industrial plants have been realizing a greater growth in electrical requirements than in heat requirements. This trend should be analyzed for a particular plant and future systems planned to anticipate all of the changing requirements.

In installing 5,000,000 kw of process-steam turbine generators in the post-war years, the ordering rate of this equipment has shown wide fluctuations. This is an area where improved forward planning should be a distinct aid to industrial power users and equipment manufacturers alike. Historical pattern of industrial plants has shown a trend from minimum expansion to periods of maximum activity every two to three years.

Last year was an excellent example of this cycle, since orders placed by industrial firms for turbine equipment reached a post-war low. Based on the historical growth rate of industrial companies and projections of the national economy, it is evident that we are headed for another period of peak activity. Equipment manufacturers' problems in engineering, manufacturing, and installing turbine equipment could be simplified if industrial users would use the periods of low activity to analyze their plants for areas of cost reduction through modernization of equipment.

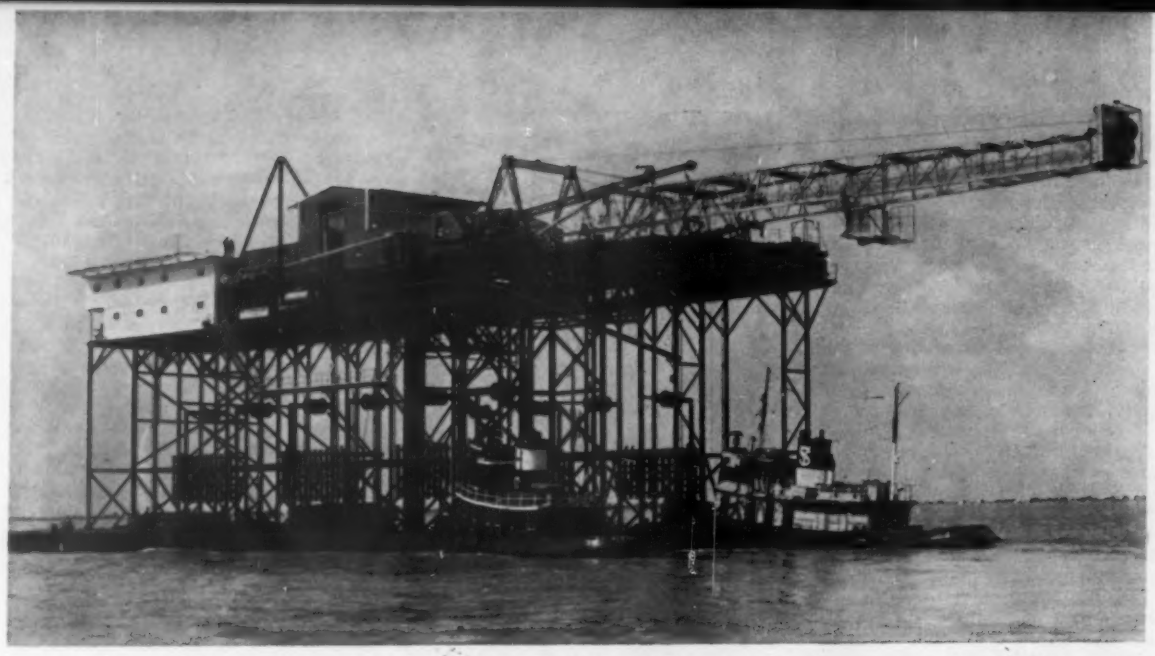


Fig. 1. Off-shore drilling rig being floated to location. Machinery platform was lifted onto supports by Lift Slab method

Lift Slab Method Can Be Valuable

New lifting technique, proved in building construction, can save time and money in the power field. System lifts from above, rather than pushing from below. Weight is no limitation, and equipment works well in close quarters; also, all shoring is eliminated

By RAY A. PINNELL, JR.*

Fig. 3. Large power plant generator being lifted into position by Lift Slab

YEAR 1950 marked the beginning of a new construction technique which has become widely known as the *Youtz-Slick Lift Slab* method of construction.

Basically, the system consists of a set of hydraulic lift jacks, mounted on top of steel columns, which lift concrete slabs, heavy equipment or other facilities into position.

Originally, the system was developed for the purpose of lifting roof and floor slabs of buildings — from ground-level to permanent elevations. For instance, in a three-story building, the roof and all three floor slabs can be cast on the ground, one on top of the other. Then, when properly cured, each can be lifted to proper position and welded into place.

Advantages of the system are obvious when one sees a building being constructed under this system. All reinforcing steel, and electric conduits, are placed at ground level; then, when the floors are ready for lifting, mechanical equipment, doors, radiation, and wall materials can be lifted with the slab.

A standard system equipment consists of a high-pressure hydraulic pump and reservoir, a control center (or panel), flexible hydraulic lines, and twelve hydraulic lift jacks. (Control panel and lift jack are shown in Figures 5 and 4, respectively.)

Method of operation is this: 1. Lift jacks are installed atop the structural building columns; 2. Hose lines are connected to the jacks and run to the control panel; 3. High-pressure hose lines are connected between the control panel and the hydraulic pump; 4. Finally, threaded steel lifting rods are installed from the lift jacks, down to lifting collars which have been cast into the concrete slabs.

When the lifting operation is ready to start, the operating engineer at the control panel opens control valves, admitting oil to the hose lines supplying the various jacks. Since the lift jacks are simple cylinder-and-piston devices, it is obvious that tremendous lifting pressure can be exerted on the lifting rods. (These jacks are modified versions of those found in the common barber chair.)

Normal operating pressure varies between 2000 and 3000 psi, as delivered by the hydraulic pump. This pressure is then applied to the jack pistons, which are approximately ten inches in diameter; therefore, the total lift approximates 200,000 lb per jack.

In conventional building construction, lifting collars are precast into the concrete slabs. These collars are of a special cast steel, and their de-

* Lift Slab Management Corp

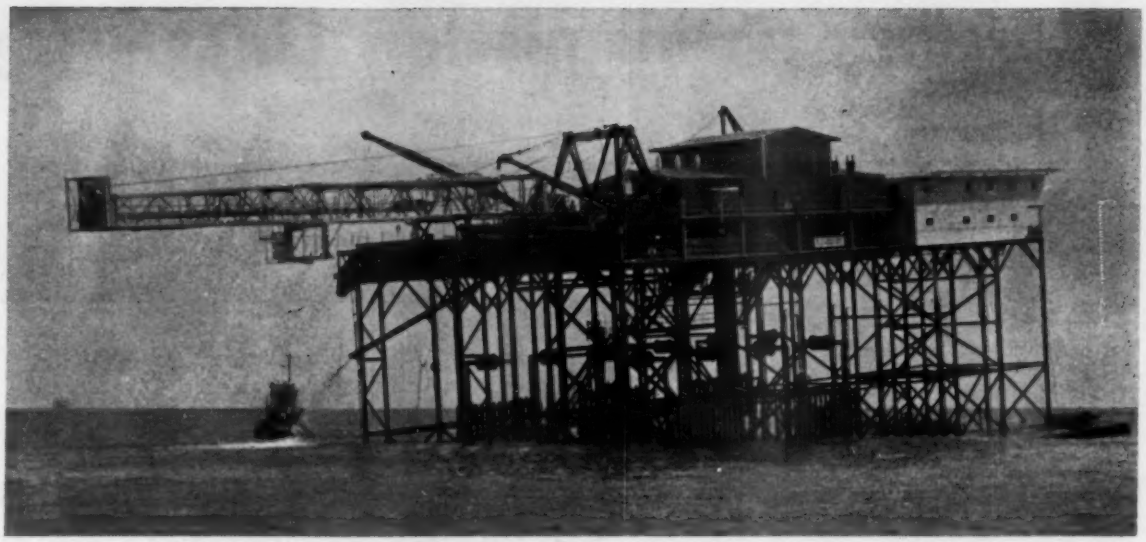


Fig. 2. Rig, in correct location, is being allowed to settle onto the bottom. Lift Slab saved time and money on this project

Tool in Power Plant Construction

sign incorporates a key-hole slot through which the lift rods can pass. However, in lifting other heavy items of equipment, special attachment lugs can be improvised to serve the same purpose as the collars.

Traditionally, heavy power equipment has been lifted into position by one of two methods: Overhead crane, or jacks and cribbing under the equipment to be lifted. And, since the overhead crane is not always available when needed, the latter method is more or less standard procedure. However, with the Lift Slab method, the cost of cribbing build-up is eliminated, and constant lifting pressure is exerted on all points of lift.

In building construction, the heavy floor slabs are lifted at a speed as high as 10 feet per hour. Any piece of heavy equipment can be lifted with a relatively high speed, once the lifting has been started.

Perfect vernier control is maintained at all times, since the control panel has counters which show the exact number of screw threads at each point of lift. And, the jack is so designed that a locking nut is kept constantly engaged to prevent any possible slack in the lift rods. Factor of safety is high, and positive control is maintained at all times.

Lift Slab equipment is rented and operated by licensed, skilled operators who act as sub-contractors. On practically all projects, Lift Slab shows a substantial saving. THE END

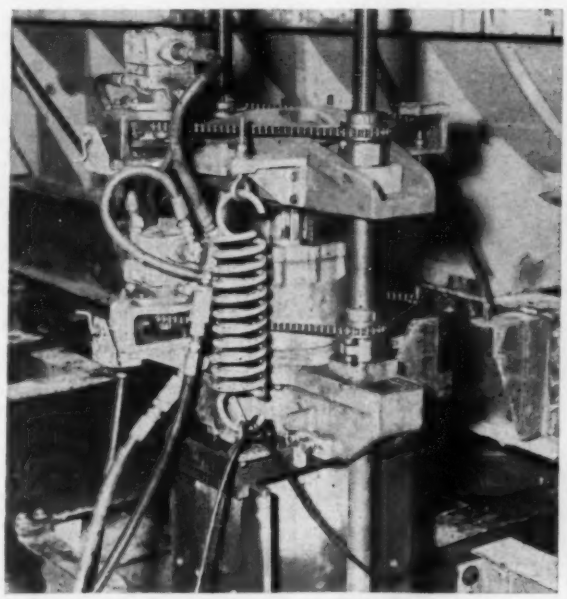


Fig. 4. Close-up view of lifting jack, which consists of the cylinder, piston, retracting spring, and nut-running chain drives

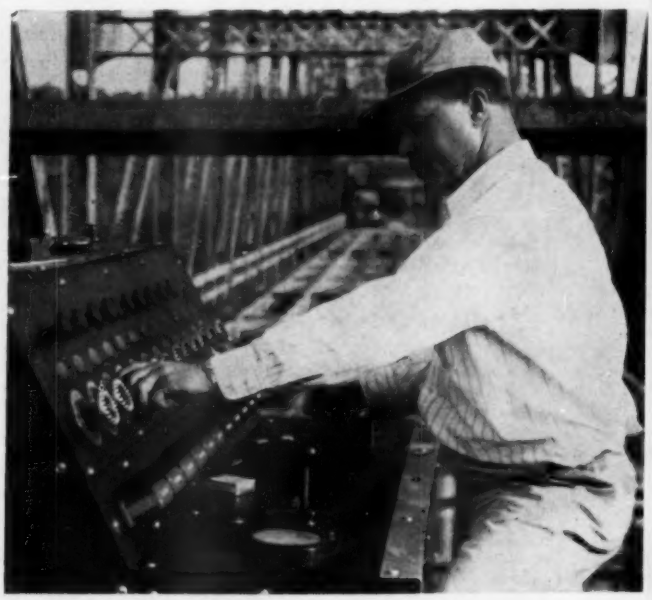


Fig. 5. Photo of Lift Slab control panel, showing operator regulating valves. One panel controls twelve lifting jacks

Electric Transmission Lines—How

Here is the second of three articles which tell how to engineer and construct electric transmission lines. Over a period of years, the author has been involved with every phase of the subject, and knows it well. This is excellent reference material for all power engineers

By E. P. NANEY *

HAVING engineered relationships in advance (over a period of years), selection of voltage, conductor size, and material become a matter of selecting a line that will serve for a period of years. And, one which will adapt itself to increased capacity for the future, by one of the methods stated in part I, published in the July issue, page 58.

In some respects this future planning determines the *span* length of a line and the *type* of structure; that is, whether it is to be a single-pole pin-type construction, single-pole suspension construction, or an H-frame type of suspension construction. One factor in determining whether the line shall be constructed of single-pole construction, or H-frame type of construction, is the *terrain*. For irregular terrain with deep valleys, the H-frame type of construction proves itself most advantageous under most voltage conditions and conductor size.

Most transmission conductors are stranded, with layers of strands that are multiples of six, around a single center strand. In extremely large conductors, this single center core may be composed of seven strands. If this core is made of steel, it is called a *steel-reinforced conductor*.

The conductor may either be made of aluminum or copper. Steel-reinforced type of conductor is far superior to the unreinforced type. Steel-reinforced conductors lend themselves to design of lines for longer spans, resulting in a lesser number of structures and cheaper insulator strings.

Our engineers recognized the advantage of steel-reinforced conductors as early as 1923, and all transmission lines constructed since that time have used this type of conductor.

Types of Structures

So far, we have talked about factors related to load, voltage-drop, power-losses, and reduction in outages due to lightning. For a transmission line to operate satisfactorily, without structural failure of components, as much attention must be given to the *mechanical design* as to the *electrical*. This is true, whether the structure is made of steel, wood, or other structural material.

Most severe design criteria is a combination of heavy icing on conductors and supporting structures, and moderate or high winds. This is known as *designing for maximum transverse loading*.

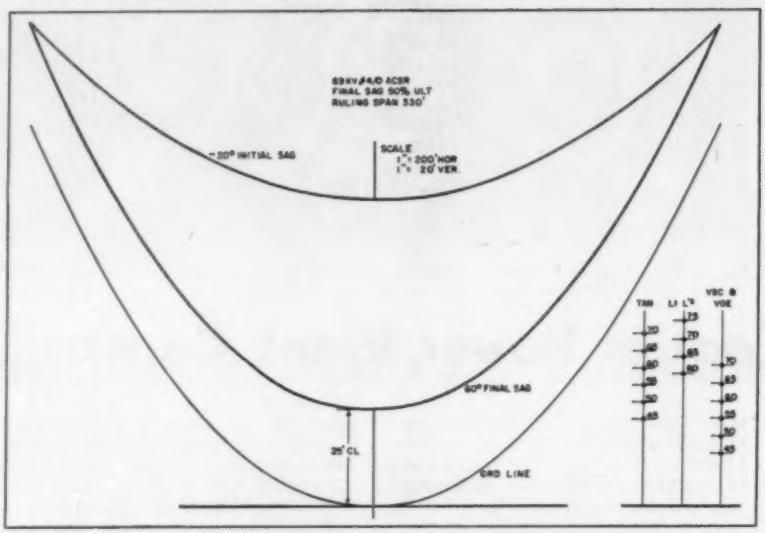


Fig. 1. Drawing shows a typical sag template, used for checking ground clearance. Top is minimum loading; middle is base conditions; bottom gives ground clearance

Conductor installation has to be engineered so as to be initially strung (and sagged) at a low tension. This gives the required factor of safety that is necessary to overcome ice and wind loading on the structures.

Supporting structures have to be designed to withstand these same forces. And, as in the case of conductors, the transverse loading on the structure is the important design feature. Also, there are other considerations to design against, such as shock on the cross arms due to breaking of conductor, and the design of special structures to accommodate full dead-end loading of all conductors attached.

In structural design, the transverse forces tending to break (or overturn) the structure are compared with the structural strength of the material of which the structure is made. The amount by which the structural design exceeds the transverse loading (under designated loading conditions) is known as the *design factor of safety*. This is influenced, on a minimum basis, by state public service commission regulations and by the National Electric Safety Code. Good judgment, based on area conditions, influences the degree to which the factor of safety shall be designed into the structure above *minimum* requirements.

Taking a single-pole structure as an example, the point of failure would most likely be at the ground line. This is the point where the elevated conductors, plus the side-pressure on them, plus the wire, exert the greatest leverage.

Since, in most instances, this is the point of greatest stress, the earth (or material in which the structure is set), also has to be given consideration. The side-pressure against a pole (above the ground line) exerts pressure against the earth at the ground line. If this earth will not withstand the pressure, the pole will tend to lean or overturn by tipping itself out of the ground. Corrective measures against this include reducing the span length, installing bearing plates, installing side guys, or placing special compacting-type back-fill around the structure at time of setting.

One of the most important factors in the economical construction of transmission lines is the determination and selection of a *routing*. A straight-line route is ordinarily selected for obvious reasons. Consideration must be given to the type of land and terrain to be crossed, in

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to Design and Build Them

case it is private right-of-way. Consideration for other utilities (and ornamental trees) must also be given. Extremely high-voltage lines ordinarily can support the extra cost of right-of-way for a diagonal routing.

Private rights-of-way are always desirable, as they avoid conflict with other utilities, usually avoid ornamental trees, and prevent future moving expense due to highway improvements. Since the advent of aerial-patroling, private rights-of-way are just as well adapted to quick patrol as routings along a highway.

The amount of clearing which may be involved also could have an effect on the selection of right-of-way. Line-routing through dense timber means *low* right-of-way procurement costs, but *heavy* clearing costs. The reverse is ordinarily true where there is little or no clearing, which usually indicates that improved land is to be crossed. Other natural adverse conditions to avoid are excessive rock or wet, unstable soils encountered in swamps.

Aerial Photos Used

We are fortunate in route selection in this area because all of the farm land in the three-state area has been aerial-photographed by the government. We make very good use of these aerial photographs, which may be purchased from U. S. Government Printing Office.

The selection of the routing is a joint endeavor between the transmission design engineers, the district operating superintendent, and the right-of-way procurement men. The judgment of all is needed for selecting a routing that will lend itself to the best engineering solution and an economical procurement, construction and operating cost. *Engineers* want the most direct route and want to avoid as many angles as possible, with minimum clearing. The *right-of-way* procurement people want to avoid impairments to the use of the land that is crossed over. *Operating* personnel (as well as engineers and right-of-way people) are interested in good relationships with the public and our customers. A compromise is always the solution.

Good right-of-way procurement people ordinarily are those who are extremely familiar with farming operations. By the use of aerial photographs, and a reasonable amount of actual observation in the field, it is possible to select a route which will not have to be changed for operating or engineering reasons.

Once the routing has been selected on the aerial photographs, the engineers and right-of-way procurement people still work together. The R/W men obtain (from Abstract agencies) the names of the property-owners enroute, including heavy title-impairment information, such as leases and mortgages. With this information, and routing map denoting sections, townships and ranges, the easements for all of the property parcels are prepared by the R/W department.

We have had our best success in procuring right-of-way by dividing the line routing into segments and assigning a *buyer* to each segment. Next, we attempt to get options for each fixture location in as short a period of time as possible.

At the time of optioning, we also obtain permission for the engineering survey crews to start their work. In this manner we virtually come to an agreement between the company and the land owner, before anyone enters the property to start survey, clearing or construction. Infrequently, the initial arrangement made between the company and owner is subject to a misunderstanding. Most of these will show up at the time the survey is being conducted and are settled jointly between property owner, right-of-way people and the engineers. They result either in restrictions on the location of structures, slight route deviations, or agreement on additional right-of-way payments. This joint method of route-selection and right-of-way procurement has been so successful that condemnation proceedings are so rare as to be insignificant.

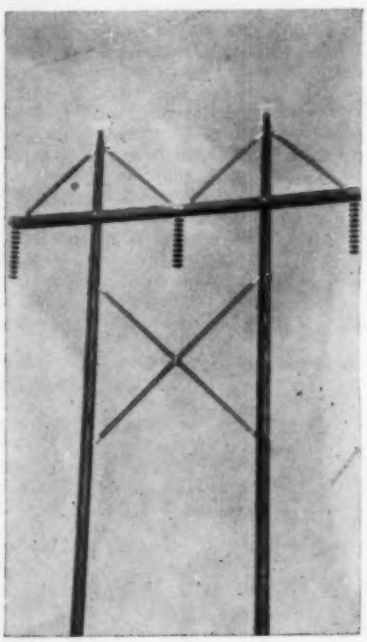


Fig. 2. Typical two-pole H-frame structure, designed for higher line voltages

We pay special tribute to the fairness and understanding attitude towards progress of the rural people in our territory. Couple this with a sincere desire to recognize their problem, and you have a formula for successful acquisition of transmission line rights-of-way.

Engineering Field Survey

After acquisition of right-of-way, an engineering survey crew makes the detail survey for the line. They run the line, set stakes at 100 ft intervals, run levels, and take pertinent notes on details affecting the line. These include railroads, fences, highways, other utilities, and man-made obstructions.

Field survey notes are then sent into the engineering department, and are translated onto finished construction drawings. These drawings provide actual fixture location, determination of material requirements, and are used for field construction.

From the field notes, the finished *survey sheet* for a section of transmission line is made. It locates the poles with respect to the fence lines and other adjacent obstructions, and also indicates the clearing required. The *profile* part of the drawing indicates ground clearances and clearances of obstructions. In-between data gives the following: structure number, survey station number, span length, structure drawing number, pole height and class, pole-framing drawing number, pole-coding number, line angle (if any), and anchoring data required.

All of this information is for the benefit of the constructor who will do the work and maintenance crews which may have to replace structure components at a later date.

On unimportant lines, where the terrain is very flat and clearances can be measured on an accurate basis without surveyor's levels, we would omit the 100-ft stationing and levels. Survey crew would stake the structure locations at the time of survey, on a predetermined average-span-length, with maximum limits. In this case the profiling part of the sheet would be omitted.

If *levels* are to be run at the same time *line notes* are taken, a sag template is applied to determine the most economical location of structures. Figure 1 illustrates a typical *sag template*. This template consists of three catenary-type curves, two of which are calculated and plotted on coördinate paper, and later constructed on transparent plastic. Top curve on the template shows sag under minimum vertical loading conditions of the conductor, which is at −20 F, no ice, and no wind. The middle curve shows sag of conductor

Fig. 3. Power engineers utilizing a network analyzer to study various elements of transmission line design. Company uses such equipment for calculating line factors

under assumed base conditions from which ground clearances are maintained. This condition is the sag in conductor at 60 deg, no ice, no wind. Third curve is the ground-clearance curve.

Ground-clearance requirements are determined by safety regulations contained in state regulatory commission regulations, or the National Electric Safety Code. These clearances increase proportionately to line voltage and have incremental increases in proportion to the increase of span-lengths over a base short-span length.

Once the ground clearance has been determined for the line, the ground-clearance curve is superimposed on the sag template, by drawing a curve that is parallel to — and below — the middle curve on the template. (When constructing a sag template, the catenary has to be considerably longer than the longest span anticipated.) In the application of the sag template to the levels on the drawing, the template has to be applied in a *plumb* position, both horizontally and vertically, and still accommodate locations at considerable difference in elevations.

Application of a sag template, in location of structures on the line profile, calls for an unusual amount of alertness, skill and judgment. The engineer must try to keep the line structures off (but adjacent to) highways, keep them in waste ground (or fence line if possible), space the line structures off (but adjacent to) maintain ground clearances, and recognize the standard variation in pole or tower height available.

Use of Sag Tables Important

Application of upper curve on the template shows how the conductor will act under no ice — no wind — low temperature conditions. This would tend to create a vertical uplift on either the insulator-tie, or insulator-string attachment. This vertical strain will invite wire breaks, on pin-type insulators with ties, and will invite an uplift on a vertical insulator string. This might decrease the clearance from phase-wire to structure, to the extent that it would cause transmission trouble. Curve is applied to every third structure, to determine uplift on the middle structure. If, when applied in this manner, the curve rides on, or above, the point of conductor attachment of the middle structure, there is uplift. A taller middle structure, or a rearrangement of adjacent structures, is required to correct the condition.

From the construction plan and profile drawings, *we make a complete bill of material and order the material for the line.* If, for reasons of haste, we have ordered the major per cent of each item of material ahead of time, we will order out the balance, including the adjusting materials for the previous orders. This procedure practically eliminates any left-over material on large projects, where it is undesirable to store excess materials. A subsequent article lists a typical *material bill.* Listing for *poles* has to be on a special form for accuracy in determining pole requirements. For efficiency and economy, poles are ordered by class, length, and drilling for each structure type. This data is correlated on one sheet for easy reference.

After the plan and profile construction sheets are prepared, and just prior to actual construction, a segment of the original engineering survey crew will set the pole and anchor location stakes. Marked information on the stakes will readily let the field construction crews identify them with the construction location drawings. This tends to eliminate errors of material distribution and erection.

Actual erection of a transmission line is done by contracting the work to skilled line contractors, or by a company's own forces. Specifications for the line erection work are prepared, for taking bids, after the engineering work is done and after delivery dates of materials are known.

Each of our jobs is let out for competitive bidding. We ordinarly take bids from not less than six *well qualified line contractors.* Information furnished to the prospective bidders, and which will also be used during construction, will include the following:

1. Routing map — 1 to 2 in. to-a-mile scale, showing the routing of the line, roads adjacent to the routing, and names of property-owners enroute.
2. Set of plans and profile drawings.
3. Set of material bills.
4. Bound set of detail drawings, for assembly of each type of structure used in the line.
5. *Written* specifications covering details of the work that either cannot be placed on the erection drawings, or that are peculiar to the particular job only.
6. *General* specifications applying to job conditions, and insurance, public relations, and safety requirements.

Editor's note: The conclusion of Mr. Naney's interesting article will appear in the next issue of POWER ENGINEERING. An actual case history of a line construction project will be given, showing how good planning and coordination paid off. THE END

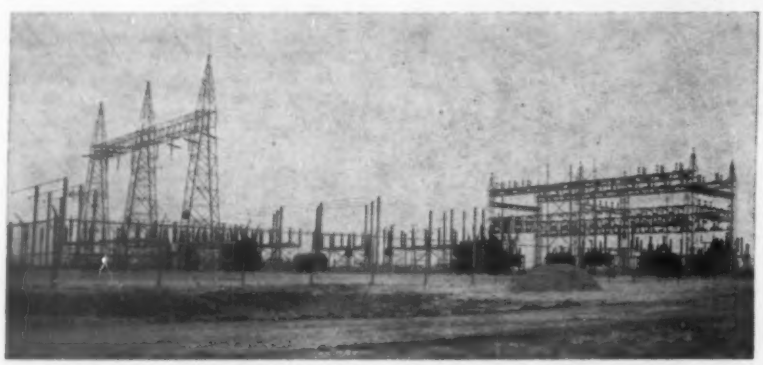


Fig. 4. One of firm's steel switching-substations; was first fed at 69 kv, later increased to 161 kv. Long-range planning provided space for future sub expansion

Desilicizer Feedwater Process Aids Scovill

By C. K. STICKNEY,* W. C. BURNS and J. W. WALTER†

SILICA IN BOILER feedwater above 400 psig forms a hard boiler scale and, more important, causes glassy turbine-blade deposits which reduce efficiency and increase outage time. The problem can be solved by boiler blowdown; but, frequently, the silica content of the feedwater is such that blowdown would become excessive. External feedwater treatment is then necessary to reduce the silica.

Most common methods for silica reduction (for medium pressure boilers) are demineralization and hot lime zeolite. Now, however, a new ion-exchange method, the *Desilicizer*, is available for economic and efficient silica reduction, without demineralizing the water.

It has long been known that strongly basic anion resins have the ability to split salts in soft water. A typical application is the *Dealkalizer*, wherein the resin, which is in the chloride active form, removes bicarbonate and sulphate-ions and exchanges them for chloride-ions. It was then determined that this salt-splitting capacity of strong base resins, when used in the hydroxyl cycle (OH active form), was capable of efficiently removing silica from soft-water supplies.

Considerable experimentation proved the feasibility of the process, and numerous small plants were installed. Chemical reactions are as follows: —

$$Na_2\ ([HCO_3]_2,\ SO_4,\ SiO_3,\ Cl_2) + 2\ AOH \rightarrow A_2\ ([HCO_3]_2,\ CO_3,\ SO_4,\ SiO_3,\ Cl_2) + 2\ NaOH$$

OR

Sodium salts + Hydroxyl anion exchanger = Exhausted anion exchanger + Sodium hydroxide.

Operation was much the same as in other ion-exchange applications.

Table 1—Desilicizer Influent

Hardness (as $CaCO_3$)	—2 ppm
Bicarbonate (as $CaCO_3$)	—16 to 18 ppm
Sulfates (as $CaCO_3$)	—27 to 33 ppm
Chlorides (as $CaCO_3$)	—2 to 10 ppm
Silica	—4 to 6 ppm
pH	—7.5
Free CO_2	—2 to 6 ppm

Table 2—Average Operating Results

	Guaranteed	*Actual*
Hardness (as $CaCO_3$)	—	2
Bicarbonate (as $CaCO_3$)	0	0
Silica	0.5–0.8	0.3
pH	—	10–11
Free CO_2	0	0

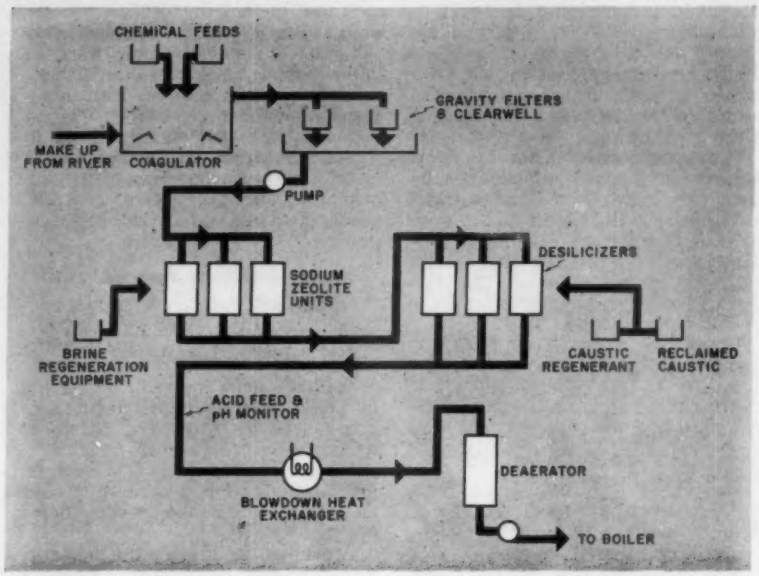


Illustration of installation of Desilicizers, in series with sodium zeolite softeners. Water then goes to acid-feeder, heat-exchanger and deaerator to boiler

However, it remained for Scovill to procure the first large industrial plant utilizing this process.

Scovill Manufacturing Co, a major producer of copper and brass products, has, through necessity and expediency, generated its own power to support its extensive manufacturing operations. The power plant at Waterbury, Conn has always been operated on an efficient basis, and has been modernized throughout the years to maintain the plant as an up-to-date operating unit.

Present Plant Improvement

The present modernization program encompassed the installation of a new 100,000-lb per hr, 660-psig, 750-degree F controlled-circulation boiler, and the necessary auxiliaries. Since boiler-feedwater treatment has always been recognized as an important phase in maintaining sound operation, considerable thought was given to furnishing this unit with a most desirable feedwater.

For the existing boiler system, makeup water was taken from the Mad River, clarified by coagulation, filtered, and sodium-zeolite-softened. In general, the surface waters in this section of the country are low in solids, and require a minimum of treatment for boilers in the medium-pressure range. However, due to major changes in terrain and river beds caused by the disastrous flood of 1955, most surface supplies changed considerably.

The silica content of the local water supply had almost doubled, with the result that silica amounted to approximately 12 per cent of the total dissolved solids. It was impossible to reduce the silica content with the existing treatment plant, and boiler blowdown had to be increased beyond the capacity of the blowdown heat-recovery system.

Operating experience indicated that silica concentration in the boiler should not exceed 30 ppm; but even with 10 per cent blowdown, the silica concentration was surpassing 40 ppm, while the total boiler salines were only about 500 ppm. Logically, if feedwater silica were reduced, to result in a balance between silica and total solids, the boiler salines could be brought up to the 2000 ppm allowable. It was estimated that a *daily fuel savings of $100* could be realized by reducing the blowdown to ⅕ its current-value.

Two major methods of silica reduction, i.e., hot-process softening, and demineralizing, were first considered. Hot-process would be very costly from an installation standpoint, in that major foundation work and feedwater piping changes would be required. The entire existing treatment plant would be useless. A demineralizer appeared to be the logical choice, but this, too, was a costly investment, because rubber-lined equipment was required, and the sodium-zeolite units would have to be considered surplus.

The *Desilicizer*, which would cost about half the price of a demineral-

* Chief Engr. of Power Plants
† Project Manager, Sales Engr., Cochrane Corp.

izer required for this application, would be cheaper to install, and would utilize all the existing treating equipment. Also, it would operate on an economical regenerant, and was considered as the most logical system to install.

Space was at a premium, and the Desilicizer was tailored into a very limited space, utilizing numerous headroom- and space-saving designs in the exchangers.

The capacity selected was 340 gpm. Since the existing sodium-zeolite softeners were capable of handling this flow (plus the rinse load of 140 gpm for one Desilicizer), they were left intact, and investment in new zeolite softeners was not required. This further enhanced the desirability of the Desilicizer installation.

There are three Desilicizer exchangers, each 5 ft-6 in. by 6 ft, designed for 75 psig. These shells are of *unlined* steel construction, and are complete with steel internal distributors, including special underdrain design.

Each unit contains 60 cu ft of Cochranex AL, a Type I non-porous strongly-basic anion-exchanger resin, operating on the OH cycle.

The valves are 3-in. unlined Cochrane Hydromatic single control valves, with integral automatic backwash and rinse regulators, which function accurately, regardless of line-pressure variations. Due to the simplicity of operation of the Hydromatic valve compared to a valve nest, a manually-operated plant was selected.

Length of run is determined by periodic silica tests and, in addition, each unit has a 2-in. totalizing meter with alarm contacts. Regeneration is effected with warm caustic from an unlined-steel measuring tank, containing electric heaters, and associated temperature controls. Part of this caustic is recovered for use in the next regeneration, and sent to a reclaim system consisting of a holding tank, electric heaters, controls, flow-indicators, and reclaim injection pump.

Water Partially Neutralized

Desilicized water (which now contains primarily sodium hydroxide, and has a pH of 10–11) is partially neutralized with a small amount of sulfuric acid, to reduce the pH to about 9.5. Acid is line-fed with a pneumatically-controlled pump which feeds proportional to flow. A pH recorder has been installed for information and record purposes. Caustic feed to the boiler is no longer needed.

As shown in Fig. 1, the makeup-water passes through a blowdown heat-exchanger, and on to a feed-water-heater.

The plant was put in service in June, 1958, and has run continuously to this date, with no outages. Table 2 gives typical analyses of the softened water used to feed the Desilicizer. Table 3 gives the guaranteed results and the actual results side by side.

This pioneer Desilicizer installation at Scovill's Waterbury plant is a proven success, and is producing water quality better than guaranteed. Since this writing, additional installations elsewhere have been placed in operation.

Silica removal from soft water, using the Desilicizer process, has arrived, and is another important tool in the arsenal of the water-treatment engineer. The process is capable of reducing silica to less than 1 ppm and, in addition, it will eliminate HCO_3 and CO_3 alkalinity, thus keeping the CO_2 content of the boiler steam at very low values. It is especially economical and practical for treatment of low-solids waters (less than 100 ppm), where silica removal is required for boiler feedwater, in the medium pressure ranges (450 to 1100 psig).

The use of unlined-shells and steel piping, plus the simplicity of operation and low maintenance of this process, are appealing advantages when compared to other methods of silica-removal. Further, a Desilicizer installation can be added directly to existing sodium-zeolite softeners, in the event boiler-pressures increase, or silica-removal is necessary. THE END

Air-Loaded Regulators Cut Control System Cost

SAVINGS of as much as 75 per cent in first cost of a single-control system installation are claimed for a series of versatile air-loaded regulating valves.

Many heating, refrigerating and food processing operations now employing a multiplicity of relatively expensive instruments can be simplified and initial costs cut through use of simple hook-ups similar to that shown in the diagram, with use of less expensive air-loaded regulators.

Diagram shows how an air-loaded temperature regulating method can be used to cut initial costs on a hot-water heating system. Most such installations use a much-instrumented control system calling for a three-way mixing valve as well as a temperature regulator to hold heater outlet temperature at a set figure.

Thermostat control for the mixing valve needs two thermostat bulbs (one outdoors, one for system water) to blend return water from the pump with hot water from heater.

Same job is accomplished with an air-loaded temperature regulator and outdoor control, thus eliminating both mixing valve and control instrument. When outdoor temperature falls below 65 F, the thermostatic control delivers a 3- to 15-psi air signal to an air-adjusted pilot. Steam shut-off adjusted to 3 psi is automatic

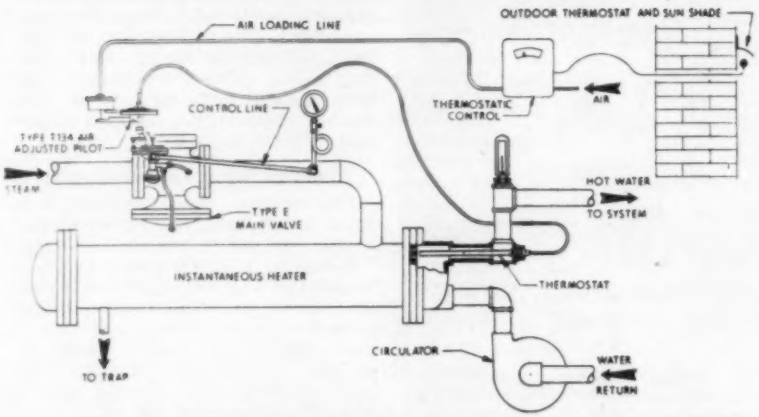


Diagram shows how air-loaded temperature regulator eliminates separate pressure reducing valve, mixing valves and control instruments in heating control system

during summer. Higher signals permit regulator to deliver required water temperature to heating system.

Same arrangement can eliminate extra valves, fittings, and controls that are now widely used in steam radiation systems. In such a system an air-adjusted pilot and thermostatic instrument controlled by outdoor temperature would simply vary steam pressure in the radiators.

There are many instances where it is necessary to control a condition at a point remote from the regulating valve. By using a simple and relatively inexpensive air-loaded regulator, the pressure-regulating main valve can be adjusted from a control station that is distant from the valve as well as the control point.

If you would like more information on these cost-cutting systems, simply write the editors of POWER ENGINEERING, 308 E. James St, Barrington, Ill, or jot "Air-Loaded Regulators" on one of the return post cards.

How We Rebuilt Our Boiler Bridges

By HERMAN A. LUDEWIG*

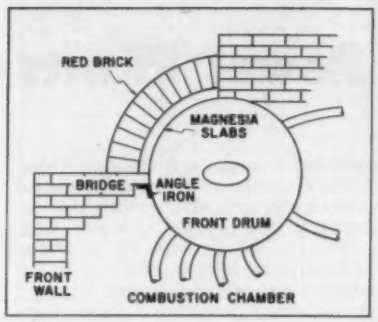


Fig. 1. This was the problem: the angle irons supporting the bridge spanning the space between the front boiler wall and the front drum loosened, became distorted, or fell down altogether. Fig. 2 shows how this area was reconstructed

BOILERS in our steam-electric plant, consisting of four 600-hp, four-drum Stirling-type water-tube boilers, were constructed in 1939. During the test runs in 1940, the bridge spanning the space between the front boiler wall and the front drum cracked to such an extent that it had to be rebuilt before acceptance by the State of New York.

In 1941 this new plant was put into operation. Then, and in the following years, we experienced never-ending trouble from this bridge (Fig. 1).

Finally, the center of the bridge on our No. 3 boiler collapsed, as feared, permitting a veritable eruption of flame and gas into the boiler room. We realized that a radical operation was necessary.

When off the line, all frontal brickwork at the drum level was removed to well below the drum center-line, and until sound structure was encountered. Wall and bridge were then rebuilt, with standard firebrick, to within two inches of the front drum (Fig. 2).

On the shelf formed by the bridge surface, we then poured a slab of fireclay and broken firebrick, about 20 in. wide, 1½ in. thick, and the full length of the wall, about 14 ft. This slab was accurately leveled and troweled smooth. It was given a slight angle of declination towards the drum.

When the slab was dry, a layer of finely shredded magnesia, about ¼ in. thick, was spread evenly over it. This was to serve as lubricant and seal for the refractory baffles, 12 in. by 15 in. by 2 in., which were to ride on its surface. They were to bridge the 2-in. gap between the drum and the bridge proper, abutting the front drum. The baffled edges, being slightly inclined, formed a fine seal with the drum and only needed fitting to the drum contour at seams and at the heads.

To maintain contact with the drum and to follow its breathing due to expansion and contraction, the scheme shown in Fig. 2 was chosen. Declination of the slab and baffles produces a natural tendency to maintain contact. To assist this tendency, a 2-in. pipe, the full length of the row of baffles, was laid on the slab, behind the baffles. Forward-pushing force is maintained on pipe and baffles by a series of springs under compression, situated equidistant along the pipe. Springs were inserted in their sockets, made of standard pipe, compressed, and the outer end of each socket was then welded into an existing I-beam. Mobility was thus imparted to the seal, so that it could follow the movements of the drum.

The front wall and the two sidewalls were now built up of red brick, to form a bed for a 7-ft thick layer of asbestos shorts, placed on top of the baffle assembly. Loose firebrick was then laid on top of this layer of asbestos shorts to keep it under compression, thus forming the final gas seal.

Since we are in the habit of hosing down our boiler tops every three to four months, we had to build a waterproof, protective roof. Our boiler walls are steel clad. On top of the front drum, ahead of the brickwork covering the boiler top but not touching the boiler drum, we laid a 2-in. pipe extending over the steel plate covering on both sides. The pipe was then welded to the plate on both sides.

On the built-up portion of the front wall, we provided a shelf of about 6-in. width, the full length of the wall. On this shelf, on its outer lip, a 2-in. pipe was next placed. Five-foot lengths of ¾-in. reinforcing rod were then tack-welded between the two lengths of 2-in. pipe, just far enough apart to form a seat for the red brick, forming the deck. As only the upper 2-in. pipe was welded in a fixed position, the whole deck was free to expand at the lower end and at its sides. Firebrick salvaged from the original construction was cleaned and used in the building of the deck.

Joints were generously buttered with Airtite, a non-hardening, asbestos-tar compound, and pushed together, leaving a joint ¼ in. by ⅜ in. wide. Joints around the periphery of the deck were allowed to be double-thick. Inequalities due to different expansion coefficients were to be absorbed in these joints. When the joints were finally troweled, a waterproof, live, smooth deck resulted.

Into this deck were built two 2-in. nipples, projecting through the deck several inches, communicating with the space below the deck. These nipples were to act as tell-tales, notifying us of any leaks through our baffle assembly. None ever showed up, so the nipples were omitted in later constructions.

In 1953–54 we reconstructed all four boilers in this manner. With the exception of some firebrick, baffles, asbestos shorts and the Airtite, all materials were second-hand. Other materials could readily be substituted, as available; the principle of operation could readily be varied to suit other conditions.

In the last five years there hasn't been a whisper of a leak. THE END

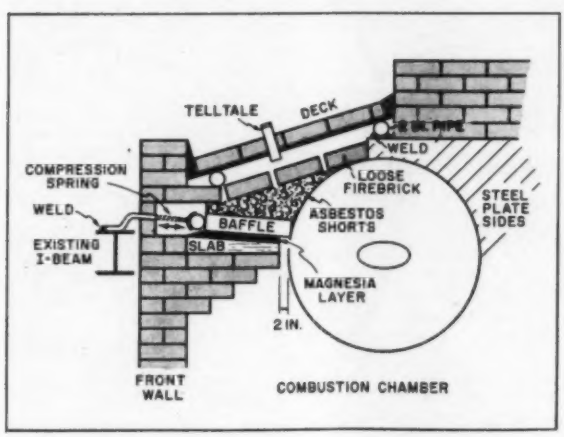


Fig. 2. Front wall and bridge were rebuilt as shown here. Declination of slab and baffles produces natural tendency to maintain contact with drum, aided by the series of springs under compression, which exert forward-pushing force. Mobility is thus imparted to the seal. Springs push on 2-in. pipe laid on the slab

*Principal Stationary Engineer, Green Haven State Prison, Stormville, N. Y.

What's the best way to solve that problem of steam supply? The consulting engineer, called in to study the situation and find the most satisfactory solution, has to have a systematic approach. Outlined here is a helpful guide to the procedure followed in .....

Designing Coal-Burning Power Plants

By **EVERETT B. WOODRUFF** *

IN APPROACHING an over-all problem involving steam supply, many questions arise, because all phases of the problem must be explored before decisions can be made which will result in the most satisfactory solution. Such questions would include the following:

What are the present and future capacity requirements? What pressure is required? What are the characteristics of the load? What type of fuel or fuels should be used in the particular location?

Also, a study must be made of the annual fixed and operation costs in connection with the investment required for the various plans that would be considered.

Annual fixed cost increases in proportion to the investment. Factors which make up the annual fixed cost are: interest on investment, depreciation and amortization, taxes, insurance, and stand-by equipment.

Stand-by equipment is always desirable from the operator's point of view. However, it requires additional investment and results in a corresponding increase in annual fixed cost. The amount of stand-by equipment to be installed must receive the most careful consideration and is influenced by the importance of an uninterrupted steam supply.

The other main division of cost is that required for annual operation. Annual operating costs consist of fuel, supplies, operating labor and maintenance. In theory, all of these costs may be decreased by increasing the capital expenditure for plant equipment. That is to say, by investing more in the plant construction, the annual operating costs can be reduced. However, as investment increases, these curves begin to straighten out and it takes more and more investment dollars to produce a given incremental decrease in operating costs; thus, an economic limit is reached.

Some of the Physical Problems

In order to determine the required plant capacity, not only the estimated present load but also the anticipated future load must be established.

Load characteristics refer to hourly, daily, and seasonal fluctuations in steam requirements. This important factor is often overlooked or given inadequate consideration. From a study of the load characteristics, the size of units, type of control system, some factors regarding firing methods, and the necessity for special equipment can be determined.

Figure 1 shows steam flow meter charts from two boilers in an industrial plant with a fluctuating steam demand resulting from a large intermittent steam requirement by production equipment. Note, for example, that at eight o'clock at night the peak load was 20,000 pounds of steam per hour on one boiler and 17,000 on the other, or a total of 37,000. A few minutes later the load dropped to about 13,000 lb per hr, effecting a large load change. These peaks occur at about equally spaced intervals in accordance with the demands of the production equipment.

The problem created by this type of fluctuating load was solved by the use of a steam accumulator. Figure 2 shows steam flow meter charts from the two boilers in the same plant about one year later after the accumulator had been installed. The variations are much less severe and the boiler controls function to maintain the pressure without difficulty. It is evident that this type of correction improves operating efficiency and reduces the necessary amount of installed boiler capacity.

A study must be made of the hourly and seasonal variation in steam requirements, as shown in Fig. 3. In this particular plant, the minimum summer load was 10,000 pounds of steam per hour and the maximum winter load was 78,000 pounds. The maximum summer load was between these values. The plant must be capable of operating at both maximum and minimum as well as at all intermediate loads. These requirements can be met either by installing a number of small generating units or by fewer large units with the ability to operate at wide variation in load. Further note, in Fig. 3, that the daily variations in this plant are not great. The activity decreases

* Project Engineer, A. M. Kinney, Inc, Cincinnati. These remarks were given at the 28th annual Fuel Engineering Conference of Appalachian Coals, Inc

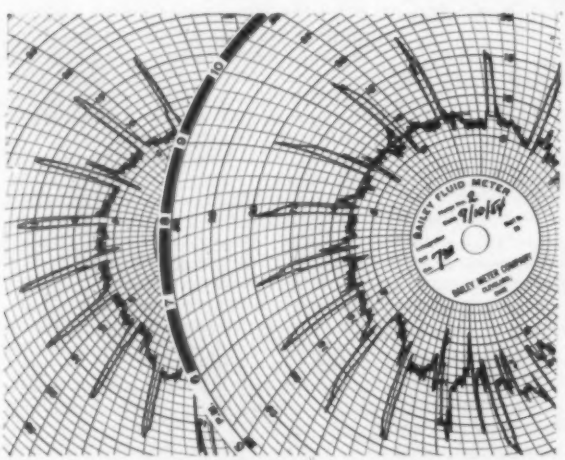


Fig. 1. Steam flow meter charts showing fluctuating loads

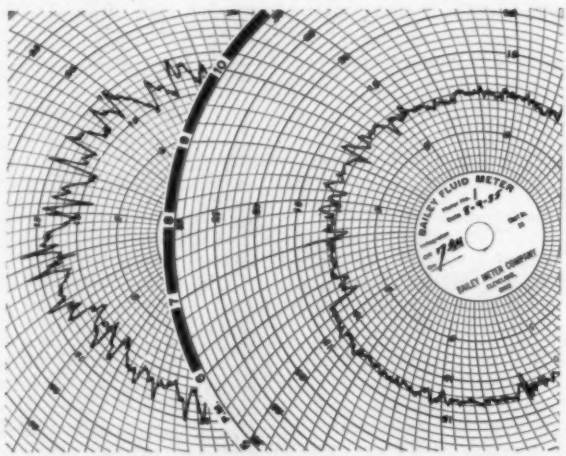


Fig. 2. Fluctuating load corrected by use of steam accumulator

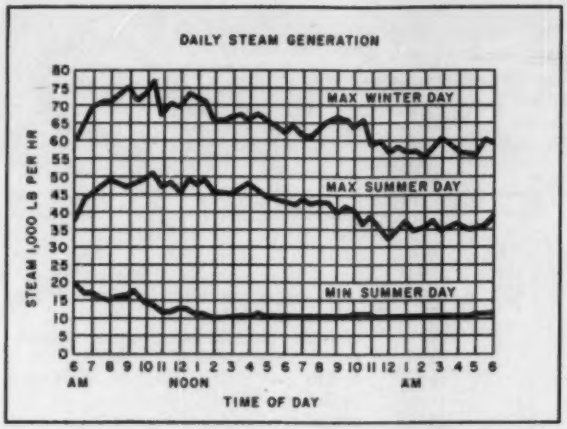


Fig. 3. Study must be made of variations in steam requirements. In this plant, seasonal variation is not very great

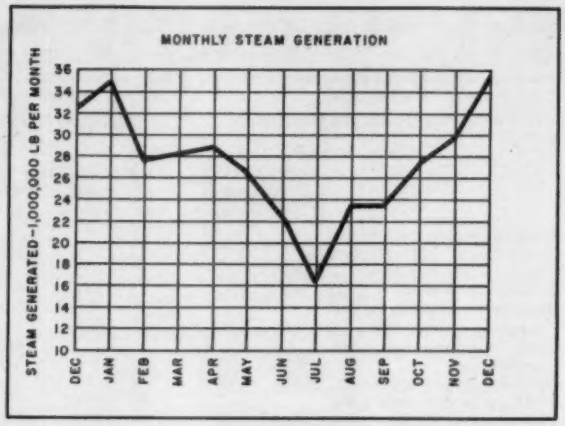


Fig. 4. This shows monthly steam generation for a typical year's operation of the same plant studied in Fig. 3

some on the second and third shift but not enough to cause difficulty.

Monthly steam generation for a typical year's operation of this same plant is shown in Fig. 4. Seasonal variation is not great except for the month of July, at which time the plant has a two-week vacation period. With this exception, the relative-steam generation is quite high, which is indicative of a predominantly high process load. This comes into consideration in the design of a plant since the high load factor assures continued use of the equipment and justifies expenditures for a highly efficient plant.

Another factor which must be considered is the type of fuel to be used. The relative cost of fuel or fuels influences the design. High-priced fuels justify refinement in design to obtain higher efficiencies. Low grade fuels, with poor burning characteristics, necessitate careful design and special arrangements to overcome the undesirable features of the fuel. Transportation facilities, reliability and proximity to the sources must be considered.

This, then, means that the cheapest coal obtainable is not always the correct selection. The analysis is important, but other factors, including burning characteristics, must be considered. Fuel cost consideration on a "per million Btu basis" is in itself inadequate. Current or possible future government restrictions on the use of certain fuels may be a factor in justifying the use of or provisions for future multiple fuel firing.

Air pollution control involves the on-site cleanliness requirements. In some locations, either because the plant is located adjacent to residential areas or because of requirements of their own manufacturing processes, small amounts of fly ash in the atmosphere cannot be tolerated. Equipment is available to clean up the boiler exit gases, but the designer must have full knowledge of the requirements.

Water supply is an important factor. This includes the quantities required, analysis, and the adequacy of the source and supply mains with respect to the present and future requirements.

Take An Existing Plant . . .

For a design problem involving an existing plant, complete data on the plant and equipment must be obtained, relating to capacities, ratings and physical condition.

One indication of the condition of a plant is the maintenance cost, and another is the reliability of the service. Abnormal maintenance costs are generally indicative of obsolete equipment and indicate that changes and improvements are in order. In a plant that has experienced difficulty in carrying the load and where there have been frequent outages, improvements can be justified.

Another important item is the grade of fuel being used or readily available to the plant as compared to that for which the plant was designed.

It is sometimes necessary to conduct plant tests to determine the thermal efficiency. Knowledge of the efficiency is essential in balancing proposed investment expenditures against possible savings in operating costs. Many factors involving operating and maintenance personnel must be studied. For example, increased coal storage facilities might make it unnecessary for the coal-handling crew to work over the week-end. This might be a highly desirable situation.

Owing to an inadequate amount of steam electric dual-driven auxiliary equipment, or because of changes in the original plant, the heat in exhaust steam may be out of balance with the steam required for heating feedwater. Either there is not sufficient exhaust steam or there is too much and it is wasted.

Consideration must be given to the possibility of installing modern equipment in the existing building or to what changes are necessary in the building. These factors may limit the selection of equipment.

Further studies involve future requirements as to pressure and capacity, character of the load, and position of the plant with respect to the location of the steam requirements.

Sometimes plant development over the years results in the main uses for steam becoming far removed from the plant, which requires long steam distribution lines. This situation might warrant higher steam pressures or perhaps the construction of a new plant more advantageously located.

With such data available, conclusions can be reached relative to the over-all procedure to be followed — whether to repair the existing plant, replace the existing equipment, make additions to the existing facilities, or provide a new plant. Usually some combination of these alternates proves best.

The Design Process in Action

Let's look at results of the design process in action, through actual cases from the files of A. M. Kinney, Inc.

In the case of Project A, a new plant was found to be the solution.

Table I. Comparison between operating present plant and new plant A

PROJECT-A

Annual Cost Comparison Present vs. Proposed New Plant (in $1000)

	Present	New	Difference
Operating labor	31	30	− 1
Fuel	119	71	−48
Electric power	16	6	−10
Chemicals and supplies	2	1	− 1
Maintenance	41[1]	11	−30
Insurance and taxes	4	9	+ 5
Total	213	128	−85

[1] Represents an average since the maintenance varied from $12,000 to $75,000 over the past several years.

Table II. Construction costs of the new plant which solved Project A problem

PROJECT-A

New Boiler Plant Construction Cost Estimate [1]

	Total Cost in $1000	Cost $ per lb of Steaming Capacity
Boilers (3) complete with spreader stokers, fans, dust, collectors, insulation and duct work	435	2.42
Coal and ash handling	90	.50
Feedwater treating, heating and pumping	35	.19
Piping, insulation, meters and controls	165	.92
Electrical equipment and wiring	65	.36
Building, foundation and site development	280	1.55
Contingencies and engineering	122	.67
Total	1192	6.61

[1] Cost estimate as of June, 1951.

Table III. This shows Project A investment paid off from savings in 21 years

PROJECT-A

Operating Cost Comparison (in $1000)
Figures are Cumulative

At End of Year	Present Annual Expense	New Plant Investment	New Plant Annual Expense	Interest 4% on Unretired Investment
0	—	1,192	—	—
1	213	1,155	128	48
2	426	1,116	156	94
3	639	1,076	384	139
4	852	1,034	512	182
5	1,065	990	640	223
15	3,195	446	1,920	529
16	3,408	378	2,048	547
17	3,621	309	2,176	562
18	3,834	236	2,304	574
19	4,047	160	2,432	583
20	4,260	80	2,560	589
21	4,473	−1	2,688	592

Investment paid off from savings in 21 years.
Estimated remaining life of plant 10 years.

The plant was to be centrally located with respect to the load and contain three spreader stoker-fired boilers, each having a capacity of 60,000 pounds of steam per hour. Other features were to include complete systems for coal and ash storage and handling, dual drive on auxiliaries to provide a heat balance, and the necessary water softening equipment.

Construction costs of this plant are given in Table II. The individual items as given total $1,192,000, and the cost per pound of installed steaming capacity is $6.61.

Comparison between the operating cost of the present and the new plant is given in Table I. The sum of the various items that make up the annual operating cost show that the new plant would result in a saving of $85,000 per year. The average maintenance of $41,000 per year, with variation of from $12,000 to $75,000 per year over the period considered, is indicative of the difficulties being encountered in the old plant.

The pay-off of this $1,192,000 investment with the $85,000 per year saving is shown in Table III as 21 years. This is made on a basis of 4 per cent interest on the unretired investment. Estimated life of this plant is 30 years, resulting in nine years' remaining life after pay-off of the investment. The plant under consideration was used mainly for heating. However, the facts developed in the survey, relating to outages condition of equipment, and the high maintenance costs, showed that a new plant was required to provide a reliable source of steam, and the pay-off became a matter of secondary importance. Actually, since the existing plant had reached the end of its useful life, a favorable pay-off was not necessary to justify new construction.

Case of Project B

Project B presents an entirely different type of problem. Two oil-fired boilers had been installed in an industrial plant to facilitate getting a manufacturing process into operation. At the time of this survey an extension to the manufacturing facilities made it necessary to increase the steam generating capacity. The studies included plant locations with respect to the existing boilers, new boiler capacities, and equipment arrangement to fill the present and predicted future needs for steam generating capacity. Consideration was given to building the boiler plant in increments to match expansion of manufacturing facilities.

Construction costs for five different plants are given in Table IV. Although the immediate expansion was to be in the order of 25,000 pounds of steam per hour, the comparison is based on 75,000 pounds, which was considered to be the ultimate.

Columns A and B give construction costs for the addition of three coal-fired boilers with oil as an auxiliary fuel. Columns C and D are for the continued use of oil as the main fuel. Alternate B involves the construction of a coal-fired plant adjacent to the existing plant. Alternate B was the plan adopted.

Anticipated annual operating costs at peak loads of 60,000, 90,000, and 120,000 lb per hr and for both coal and oil firing are given in Table V. This table is based on oil firing and a combination of coal and oil.

As mentioned, the two oil-fired boilers had been previously installed to expedite getting the plant in operation. It was not economically feasible to convert these units to the use of coal. Moreover, it was found that these oil-fired units would only be required for emergency, and during very cold weather. Costs given in the table take into account these conditions and show the annual savings resulting from the use of coal and oil as compared to oil. Difference in the construction costs of these plants is also given.

Problem in this case was to determine the correct procedure to follow in providing increased capacity. The need for increased capacity had already been established. THE END

Table IV. Construction costs for five different plants, Project B

PROJECT-B

Summary of Construction Cost Estimates [1] (in $1000) of Plans for Increasing the Capacity of a 2-Boiler Oil-Fired Plant

	A-Coal & oil	B-Coal & oil	C-Oil	D-Oil	Alternate-B
Boilers	113	113	95	98	108
Boiler auxiliaries	101	102	—	—	102
Feedwater accessories	24	24	24	31	22
Piping and controls	203	204	200	226	119
Oil storage and handling	7	7	33	33	—
Electrical equipment	18	19	11	11	14
Building and foundations	123	124	75	83	97
Site development	40	40	33	33	7
Coal and ash systems	86	87	—	—	118
Contingencies & engineering	107	108	72	77	88
Incremental cost for 75,000 lb per hr capacity					
Total	822	828	543	592	675
Per 1000	10.9	11.0	7.2	7.9	9.0

[1] Estimates as of June, 1954.

Table V. This table is based on oil-firing, also shows coal and oil

PROJECT-B

Anticipated Annual Cost and Investment Comparison (in $1000)

Peak load—lb per hr	60,000		90,000		120,000	
No. boilers—oil fired	3	2	4	2	5	2
No. boilers—coal fired	—	1	—	2	—	3
Annual cost:—						
Fuel	128.0	85.5	192.0	119.0	256.0	144.5
Labor	48.2	52.4	70.0	74.2	70.0	74.2
Chemicals & supplies	2.2	2.2	3.3	3.3	4.4	4.4
Electrical power	2.4	3.9	2.9	4.9	3.5	5.9
Maintenance	6.4	9.4	9.0	13.8	10.8	17.2
Insurance	2.2	3.1	2.7	4.1	3.7	5.6
Taxes	1.6	2.4	2.5	3.7	2.7	4.3
Totals	191.0	158.9	282.4	223.0	351.1	256.1
Annual saving	Base	32.1	Base	59.4	Base	95.0
Investment cost:—						
For added capacity	168	340	291	526	414	674
Difference, coal-oil	—	172	—	235	—	260
Per 1000 lb of steam per hr	6.72	13.60	5.82	10.52	5.52	9.00

CONSTRUCTION NEWS

Andalusia, Ala. — Alabama Electric Coöperative, Inc, 231 S. Cotton St, has authorized plans for the construction of a steam-electric generating plant in this city. Work to cost a reported $2,000,000 will get under way at once on construction of the new facility which will be completed by early 1961. Burns & McDonnell Engineering Co, Kansas City, Mo, is consulting engineer.

Daggett, Calif. — California Electric Power Co, 3771 W. 8th St, Riverside, Calif, has plans under consideration for the construction of a new generating station for the production of electric power on large site located near here. Work on the new facility is scheduled to begin in the fall of this year with completion planned for the fall of 1962. Plant will have an initial capacity of 66,000 kw and will be of the cool-water, steam generating type. Company has announced a cutback this year to $13,104,600 from $22,000,000 in 1958 for plant construction. Company has announced completion of its 80,000-kw Yuma-Axis plant, which will go on test in the very near future. Cost of the proposed plant, unannounced, will represent a multi-million dollar investment.

San Francisco, Calif. — Pacific Gas & Electric Co, 245 Market St, this city, has plans under consideration for the construction of new power plant and has filed an application with the Federal Power Commission for permission to build the plant. New facility, to be known as the Stanislaus Power Plant, will have an initial capacity of 82,000 kw and will be constructed as a semi-outdoor plant, with penstock pipe and switchyard, including a 2000-ft concrete afterbay dam. Estimated cost of the new project reported to be about $10,700,000.

Bridgeport, Conn. — United Illuminating Co, 80 Temple St, New Haven, Conn, has authorized plans for the construction of a second unit at company's Bridgeport Harbor electric generating plant, on the west side of the Pequonnock River. Work on the super-structure for the new unit has already begun, and installation of a new steam-electric unit with a capacity of 150,000 kw will begin this fall. Jackson & Moreland, Boston, Mass, is consulting engineer of the work which will cost approximately $29,000,000 when completed. Installation of new unit should be completed before summer of 1962.

Tampa, Fla. — Tampa Electric Co, Cass and Tampa St, has authorized construction and work is already under way on a third unit installation at company's Gannon Station. New facility is expected to be placed in line in early spring of 1961, and when placed in operation will have a rated capacity of 175,000 kw. Company's construction expenditure for this year will be slightly below last year's expenditure of $23,000,000, but it is anticipated that future expansion will require expenditures of about $25,000,000 annually to keep astride of the area's growth.

Waukegan, Ill. — Commonwealth Edison Co, 72 W. Adams St, Chicago, Ill, has announced contract award to the Bechtel Corp, 220 Bush St, San Francisco, Calif, in the amount of $32,000,000, for the design and construction of a new steam-electric generating unit, high-pressure boilers and turbine generator, to be installed at company's Waukegan Station on Greenwood Ave, near Lake Michigan. New unit will have a rated capacity of 305,000 kw, and when completed in 1962 will increase station's total generating capacity to better than 1,000,000 kw.

Detroit, Mich. — Power Reactor Development Corp, % Detroit Edison Co, 2000 Second Ave, this city, has announced that construction is moving ahead of schedule on the $75,000,000 Enrico Fermi atomic power plant installation, near here, which is scheduled for completion by late 1960. Nuclear portion of the plant will be owned and operated by Power Reactor Development Co, a non-profit group of 21 companies. Research, basic design and testing are responsibilities of the Atomic Power Development Associates, Inc, another non-profit group of companies. The plant's non-nuclear portion, a 150,000-kw turbine generator station, will be run by steam from the reactor section.

Jackson, Mich. — Consumers Power Co, Consumers Power Bldg, has authorized plans for the construction of a new power plant on Lake Michigan, near Port Sheldon, to be known as the Port Sheldon Power Plant. Work is already under way on the installation of a 265,000-kw steam-electric generating unit, which will represent an investment of approximately $20,000,000.

Minneapolis, Minn. — Northern States Power Co, 15 S. Fifth St, this city, has authorized plans for a major expansion and improvement program at company's Black Dog Generating Station, located on the Minnesota River, just south of here. Plans call for the installation of a new steam-electric generating unit with an initial capacity of 156,000 kw, along with high pressure boilers and accessory equipment. Work will get under way late this fall under supervision of the Pioneer Service & Engineering Co, Chicago, Ill, at a cost reported to be about $25,000,000. Completion of the unit is slated for mid-1961 or early 1962.

East Orange, N. J. — Public Service Electric & Gas Co, 80 Park Place, Newark, N. J., has authorized plans for the construction of a large electric substation on Tremont Ave, this city. Work will get under way at once on the $2,000,000 installation, which is scheduled for completion by the fall of 1960.

Anardarko, Okla. — Western Farmers Electric Coöperative, this city, has announced contract award to the Richards Associates Co, Carrollton, Ga, for the installation of a 68-mile kv electric transmission line to extend company's service area. Work will begin soon on the new transmission line and should be completed late in 1960. Cost is reported to be approximately $900,000.

Eugene, Ore. — The Water & Electric Board of the City of Eugene, Ore, has authorized construction and work is already under way on the city's Carmen-Smith hydroelectric project, estimated to cost between $19,000,000 and $24,000,000. Plant, when completed, will have an initial capacity of 56,250 kw, and tentative completion date is targeted for the fall of 1962. The City Board plans a bond issue late this year for the financing of the project which will supply power for the growing needs of the Board's 26,495 customers in this area.

Rapid City, S. D. — Black Hills Power & Light Co, 621 Sixth St, this city, has authorized plans for the construction of new power plant to be located near here. Installation will include a 22,000-kw turbine generator unit and accessories, high pressure boilers and auxiliary equipment. Stearns-Roger Manufacturing Co, 660 Bancock St, Denver, Colo, has been awarded the construction contract, reported to be about $5,000,000. Work on the project is now under way, is scheduled for completion by fall, '61.

Blackwell, Texas — West Texas Utilities Co, 1062 N. Third St, Abilene, Texas, has authorized plans for the installation of new 96,000-KVA electric power plant near here. Work on the new facility will get under way at once at a cost reported to be approximately $1,000,000. Working contract has been awarded to the Sargent & Lundy Co, Chicago, Ill, consulting engineers of the installation which is scheduled for completion by spring, 1961.

Dallas, Texas — Dallas Power & Light Co, 1506 Commerce St, has announced plans for the construction expenditures for increased capacity and general plant improvement of approximately $17,500,000 through the year 1959, up from a 1958 expenditure of some $15,256,000. Construction expenditures and cost of plant improvements in 1960 are estimated at approximately $20,200,000.

Richfield, Utah — Gar-Kane Power Association, a southern Utah electrical distributor headquartered here, has announced plans for a $2,000,000 expansion program of company facilities in southeastern Utah and northern Arizona. Plans call for the installation of two sections of power and transmission lines near the Glen Canyon dam site at Page, Arizona. Work will include installation of some 36 miles of 69-kv line from Paris Junction to Fredonia, Ariz, and 32 miles of 138-kv line from Henrieville, Utah, to Paris Junction. Work will get under way soon for possible completion by the spring of 1960.

Correction Note: Page 101, June, 1959 Construction News. Item headed Somerset, Mass. It reported incorrectly that Montaup Electric Co has awarded contract for a new 600,000-kw generating plant at Brayton Point. This report has doubtless resulted from three unrelated items.

1. Montaup Electric Co has recently installed a 100,000-kw unit in an extension to its existing Somerset generating station. The unit, scheduled for operation in July, 1959, cost $20,000,000 plus $2,000,000 for additional coal unloading and handling facilities.

2. During the past few years, Montaup Electric Co has acquired a new site in Brayton Point, South Somerset, Mass, on which it plans eventually to build a 600,000-kw station. However, no plans have been made and no contracts have been awarded nor contemplated in the near future.

3. New England Power Co, 441 Stuart St, Boston 16, Mass, has also acquired a new site on Brayton Point, South Somerset, Mass, for a genrating station, and preliminary work in connection with it has been announced in the public press.

How to Maintain Centrifugal Pumps

10 — Alignment

BY J. A. CABLE and O. M. KRISTY, Jr*

COUPLING alignment, while the subject of the last chapter in this series, is first in importance in trouble-free operation.

Coupling alignment must never be slighted or treated lightly. It should be made correctly during the installation, checked before initial operation, rechecked shortly after obtaining full-load operation for the first time, and rechecked at least once a year.

Constant vigilance will pay dividends in long hours of trouble-free operation and fewer replacement parts. Misalignment causes abnormal wear to both the pump and driver, thus doubling unnecessary repairs. Misalignment can cause or contribute to the following troubles: 1. hot bearings — pump and drive, 2. worn or seized wearing rings, 3. broken shaft (of either or both machines), 4. worn coupling parts, 5. rubbing of close clearances of drive, and 6. general noise and vibration.

For proper operation a coupling must be installed and aligned perfectly. Experience will verify that a flexible coupling operating with an alignment held within .001 in. of elevation, sideways, and parallelism or gap, will operate longer, smoother and quieter than the so-called "close" alignment having a tolerance of .003 or larger. A flexible coupling will not give optimum operation with misalignment.

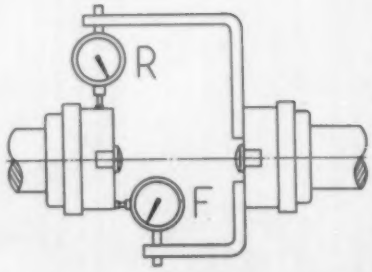
It is important with any electric motor drive furnished with sleeve bearings, to prevent the motor from thrusting a shaft shoulder on a bearing face. This can be prevented by using thrust pins with a rubber pin and bushing type of coupling and by restricting the end float of the gear type by physical placement of the coupling hubs on the respective shafts. The flexible shim type is inherently a limited-end float type (see chapter 8, on couplings, POWER ENGINEERING, June, page 102). The gear and spring-grid type of couplings can restrict the end float by use of "rung-spacers" of specified size.

There are various acceptable methods for making alignment, using the following equipment: scale, feelers, dial indicator and clamps, taper gage (marked in thousands of an inch), and inside micrometer. Method used depends entirely upon the physical size, speed and horsepower transmitted.

Small, low horsepower (15–50 hp or less), low speed (1750 rpm or less) machines are successfully aligned with straight edge and taper gage or feelers. It is recommended that any pump of 75 hp or greater, with 1200 rpm or greater, be aligned with a dial indicator and taper gages or feelers. With virtually any horsepower and speed and a spacer type of coupling, an inside micrometer or second dial indicator (indicating both the coupling rim and face) should be used to make proper coupling alignment.

* Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

—fold along this line—outside edges toward you—



Method of mounting and arranging dial indicators

One method of making a good alignment, that has proved itself through years of field experience, is described as follows:

In the figure, R indicates the rim run-out, while F indicates the face run-out of this left half coupling. Indicator mounts must be sturdy and secure with no sag, else false readings will be obtained. Inasmuch as both half couplings are rotated together on their individual center lines, the indicators are mounted on one half coupling and read on the other half coupling. To find the common center line for both half couplings, use the following procedure:

1. Set the R indicator on rim as shown at zero reading and located on top dead center of the rim of the left half coupling.

2. Set the F indicator on face as shown at zero reading and located on face of the left half coupling.

3. Mark off quarters of both rim and face.

4. Turn left-half coupling 90 deg, then turn the right-hand coupling 90 deg (same direction) so that both indicators come back to marks where they started. Record readings of both indicators.

5. Repeat turning both coupling halves together so that readings are taken at 90, 180, 270 and 360 deg (or back to the starting location).

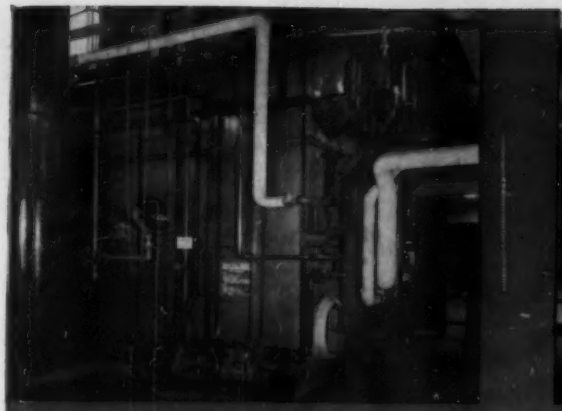
Sum of the reading across quarters (top to bottom, left to right) divided by two will measure the displacement of one shaft center-line from the other or the degree of parallelism existing between faces of the coupling halves.

Readings across quarters must always add up; that is, the reading top and bottom must equal the reading of left side and right side. If they don't, either the position of the half couplings has not been maintained on the quarter turns or the indicator bracket is not secure and is sagging, both of which will give faulty readings and prevent good alignment. Note that feelers, gap gage or a micrometer (if space permitted) could be used in place of the face indicator, depending upon the magnitude of the distance between the faces.

Because both half couplings are rotated together, with readings taken on the quarter turns, a true reading of center-line displacement is measured. Small amount of coupling hub "out-of-roundness" or a hub face with small "run-out" will not affect the readings due to rotating both coupling hubs together. This method is quick and accurate if care is exercised in maintaining the initial position of both half couplings at each quarter turn.

Final alignment before running the unit should be done with complete suction, discharge and auxiliary piping installed. Also, all permanent pipe hangers must be installed and set for operating loads. It is wise to loosen all piping at the pump and check to be certain that no strain is being imposed on the casing. By so doing, all causes for the troubles outlined at the start of this chapter can be avoided. Last but not least, see to it that good alignment, once obtained, is maintained.

This chapter concludes the Cable-Kristy series on centrifugal pump maintenance, which began in the Handbook in October, 1958. Reprints are being planned. If you would like a set, write The Editor, or jot Centrifugal Pumps on the postcard in this issue



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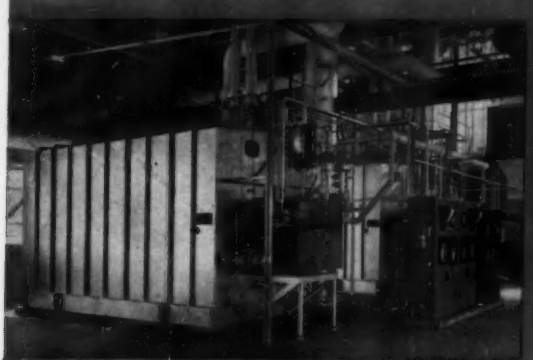
Placed on a suitable foundation, only fuel, water, breeching and steam connections need to be made to place unit in operation. Vogt Package boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage.

One of two 30,000 lbs/hr units for a hospital



Two 25,000 lbs/hr units installed in a manufacturing plant

This 18,000 lbs/hr unit is one of two for an office building

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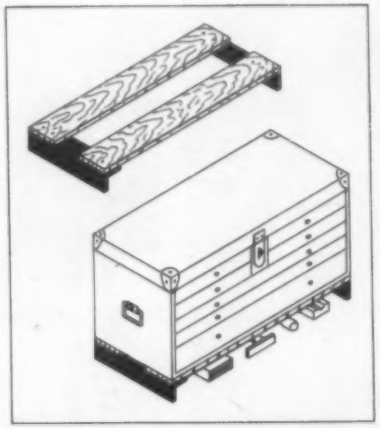
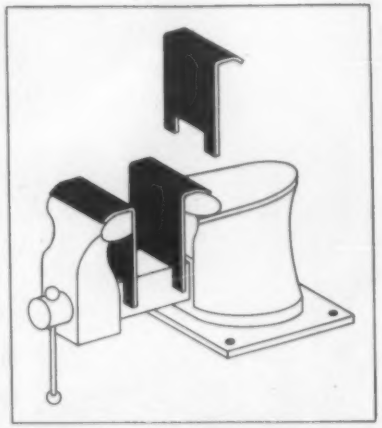


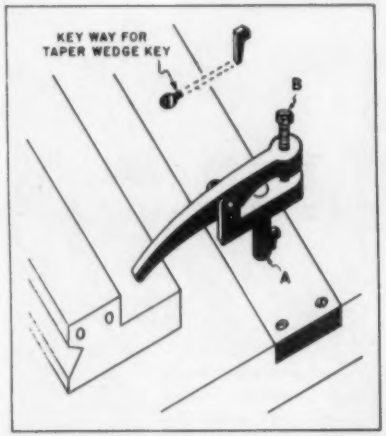
Tool organization will get a boost from this practice: set your tool chest on angle irons made up into a bench rack as shown. This frees bench surface, heavier tools now being kept under chest



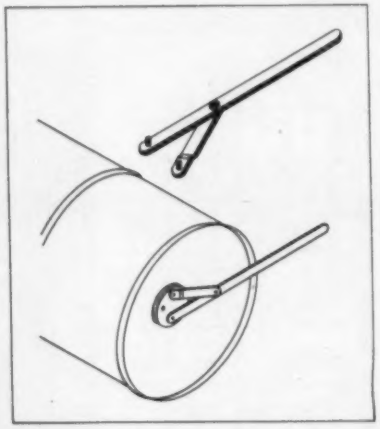
Here's how to make auxiliary jaws which will expedite finish work at bench vise. Cut and form jaws from soft brass or copper to width and fit of the bench vise. Such jaws prevent injury to work

By CHARLES H. WILLEY

Four Ways to Make Work Easier

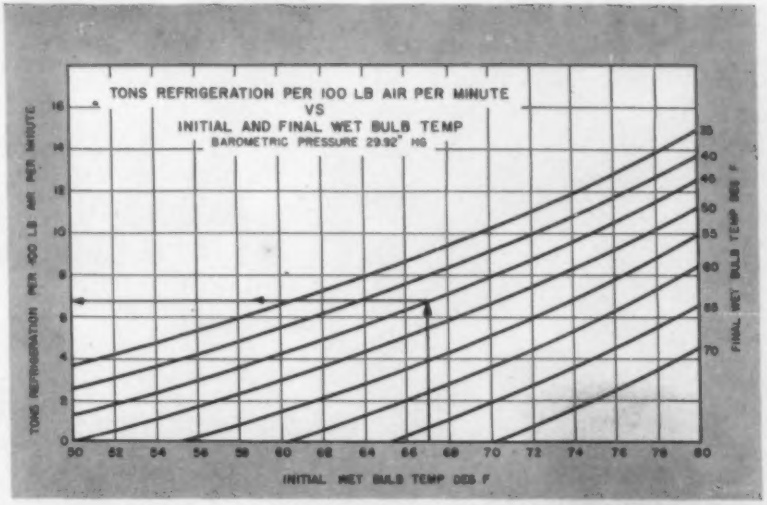


This bench holdfast is handy for use on work too bulky for the vise. Holes in the flat steel bar have diameter of leg of clamp, A. Key way holds taper key. Screw B operates clamp finger



Ever wasted more than a few precious minutes struggling with opening a tight drum plug? This easily-made spanner is self-adjusting to many sizes of plugs. Form it out of two or three pieces

fold along this line—outside edges toward you



This chart provides a convenient way to figure the tons of refrigeration needed at the humidifier

Refrigeration Needs for Cooling and Dehumidifying Air

By JOHN D. CONSTANCE, P.E.

WHEN COOLING and dehumidifying air, a convenient method of estimating the refrigeration load is the one shown on the accompanying graph. If the initial and final (entering and leaving) wet bulb temperatures are known, together with the weight of air flowing in pounds per minute, then the chart may be used to give the tons of refrigeration needed at the dehumidifier. To this load must be added the regular losses in the refrigeration system.

Example: 2000 cubic feet per minute at 95 F dry bulb and 75 F wet bulb are to be cooled and dehumidified to 80 F dry bulb and 67 F wet bulb. What is the refrigeration load at the dehumidifier?

Answer: Specific volume of air (cu ft per lb) at initial conditions is for all practical purposes 13.8. Therefore, weight of air flowing per minute is (2000/13.8) = 145 lb per min.

From chart, obtain 3.2 tons refrigeration per 100 lb air per minute.

Refrigeration needed is thus 3.2 x 1.45 = 4.64 tons.

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EQUIPMENT NEWS

Reader Service Cards on pages 115–116 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—MANUAL CONTROL VALVES come in various metals

Handwheel valves in the Series LM feature a single-seated valve body with thick body walls cast to 600-lb ASA rating and are available in ductile iron, steel, bronze and many alloys. They are suggested as a solution to corrosion and erosion problems encountered when using "hard-to-handle" process fluids. Sizes range from ¾ in. through 6 in. Micro-flow control is accomplished by the combination of a vernier position indicator, long stroke, and oversized handwheel. If fully automatic or remote manual operation is desired, the series LM Valve can be converted in the field by mounting a pneumatic cylinder or spring and diaphragm actuator. Bulletin LM-1 gives details. Conoflow Corp.

2—SOLVENT DETERGENT routs carbon from engine parts

Composition 111 is formulated to remove carbon from pistons and clean a variety of engine parts. It can be mixed with water or with petroleum distillates, used at room temperatures or heated to about 100 F, rinsed with water or steam. It contains no phenolics, so disposal of spent solutions presents no problem, it is pointed out. Oakite Products, Inc.

3—METERING PUMP is durable, economical in cost

Model CM is introduced for metering clear and corrosive liquids to chemical processes. This economical, controlled volume pump is intended for metering

situations requiring low-cost durability with accuracy. Model CM delivers maximum capacities to 28 gph in simplex designs, and double that gallonage in duplex designs (two liquid ends with common motor and base). The pump is designed to handle pressures to 1100 psi. Model CM features simplified construction. Plungers are interchangeable within the pump frame, and models can be converted in the field from simplex to duplex capacity. The pump utilizes a standard ½-hp drive, constant speed electric motor through a right-angle gear reducer. The motor is an open, drip-proof, single-phase, 115-v, 60-cycle unit. Materials include steel, stainless steels. Milton Roy Co.

4—AIR CONDITIONERS provide 40 to 700 cfm, ventilation

Inductor Air Conditioners provide heating, humidification, cooling and dehumidification for perimeter areas of office buildings and other multi-room structures using conventional ductwork and requiring relatively large volumes of air for ventilation. The units come in five sizes. Up to 700 cfm of fresh air can be supplied by each of the low pressure conditioners.

Individual room control of primary air is provided by a standard indexing and locking device for fixing unit volume. This control can be field set. It can also be manually operated through a remote control arrangement. The secondary coil, hot water or steam, can be controlled by a hand valve from the standard access door. Automatic electric or pneumatic control valves can be used, but must be installed on the job. Industrial Div., American Standard.

5—POCKET PENETROMETER for soil classification

Bearing capacity of cohesive soils can be determined rapidly in the field with the improved Model CL-700 Pocket Penetrometer. New features incorporated include a maximum recording ring on the barrel of the calibrated piston, a direct reading scale in unconfined compressive strength or bearing capacity in tons per square foot or kilograms per square centimeter, and smaller size. The maximum indicating ring stays in fixed position after the reading has been taken and can be returned to zero position by a flick of the finger. The instrument comes in plastic carrying case with belt loop. Soiltest, Inc.

6—CONTROL SYSTEM keeps the boiler water clear

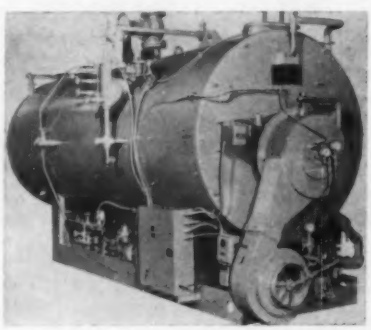
In standardized models for all types of steam boilers up to 1000 hp and customized units for boilers to 6000 hp, the low cost Filtrion Automatic Side-Stream Boiler Water Control is designed to keep boiler water clear by eliminating sludge and suspended solids. Comparison tests with a conventional treat-

ment program are reported to show savings up to 20 per cent on fuel consumption, up to 75 per cent on treatment chemicals, and on blowdown heat and water losses, and up to 100 per cent on contaminated condensate losses. Reduced operating costs are claimed.

The system is based on continuously recirculating boiler water through a side-stream filter pre-coat that reduces suspended solids to a value close to zero. Company points out that these units also combine side-stream filtration with chemical pretreatment, internal treatment, continuous minimum blowdown and feedwater preheating and degassing with the system and are automated. Sparkler-Filtrion Corp.

7—FUEL BURNING UNIT for oil, gas or combination firing

In this fuel burning unit, a feature of the air register is an easily operated handwheel to control the setting of the air vanes through a chain and sprocket for either clockwise or counterclockwise air rotation. To prevent binding or sticking of the vanes, the shafts on which they are mounted are of stainless steel, and they turn in carbon graphite bearings. Vane adjustment is easier for this reason, according to manufacturer, because shafts cannot become warped or immovable by heat, or bind due to corrosion or rust. Control is described as precise without lost motion, particularly in adjusting the vanes when they pass dead center. The unit is available with oil or gas burners. The Engineer Co.



8—PACKAGED BOILERS offer design improvements, economy

Oil and gas burner improvements, lower first cost, greater compactness for easier installation, more centrally-located simplified controls, operating and maintenance economies are announced for the Model AA Air Atomizing Amesteam Packaged Steam Generators. The new boiler design incorporates a low pressure, air atomizing oil burner and a ring type gas burner designed to provide stable, uniform flame patterns and burn all grades of oil or gas cleanly and at low noise levels over a modulating range of 5 to 1. Units for heavier oils include

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What are your specifications for small, high-pressure, steel power plant valves? These three classes of Crane Lip-Seal Bonnet Valves will meet them accurately—and give you many exclusive service features as well! They're available in globes, angles and lift-checks*—in the following ratings:

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1570 psi, 1050 F (2500-Pound ASA)—in Crane No. 7 chrome-moly (WC6)

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... And each class complies with ASA standards**

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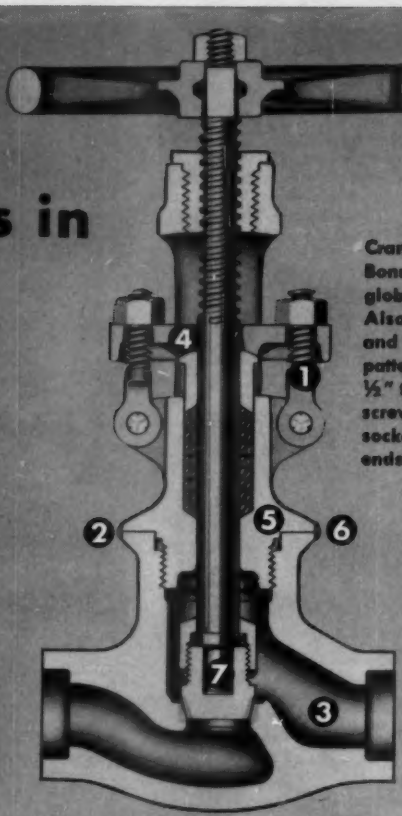
****All Crane Lip-Seal Bonnet Valves are ASA-rated**

Minimum metal thicknesses comply fully with the requirements of ASA B16.5-1957, as well as ASA Code for Pressure Piping and ASME Boiler and Pressure Vessel Code.

*Check valves not available in 2520 psi rating.

Write today for Crane Lip-Seal Bonnet Valve Bulletin AD-2373



Crane Lip-Seal Bonnet Valve, globe pattern. Also in angle and lift-check patterns. Sizes ½" to 2"; screwed and socket-welding ends.

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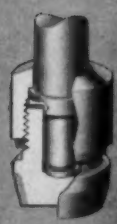
1. **Stainless steel eyebolts—prevent corrosion.**
2. **Welded bonnet joint—eliminates bonnet joint maintenance.**
3. **Compact design—with no sacrifice of strength, or size of port area.**
4. **Two-piece, ball-type packing gland—prevents binding on stem.**
5. **Body-centering lip—assures perfect body-bonnet alignment.**

6. Exclusive body-bonnet lip design—permits fast grind-off and easy rewelding. Lip-Seal weld carries no mechanical load—merely seals the bonnet joint.

7. Improved disc-stem connection—brings stem thrust closer to sealing surface; assures positive closing, minimum vibration—without hampering swivel action of disc.



CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

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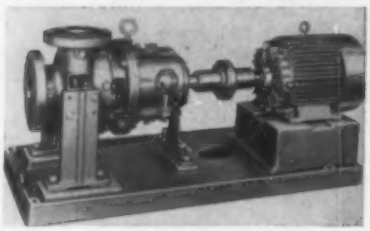
combination steam and electric fuel preheaters; No. 4 oil may be burned with little or no preheating, says manufacturer. Since the Model AA requires smaller motors and fuel preheaters, power costs are reduced. A complete package, including boiler, burner, controls, refractory and insulation, the new Model AA utilizes manufacturer's three-pass concentric tube design, single one-piece baffle and one-piece flue covers. Ames Iron Works, Inc.

9—PROCESS PUMPS for oil refineries, petro-chemical plants

These pumps are designed to meet requirements of refineries and allied industry applications, as well as hot water circulating applications. Figure 3775, an enclosed impeller type centrifugal pump (illustrated) is a center line mount unit



with vertically split casing, water cooled seal chamber and bearing housing, and internal mechanical seal. The pump's back pull-out design facilitates maintenance. By using a spacer coupling, complete removal of rotating parts is possible without disturbing pipe connections or driver. Built in 11 sizes, Figure 3775 can pump up to 850 gpm. Maximum working temperature is 600 F, maximum working pressure is 550 lb. Hydrostatic test pressure is 1100 lb.

Figure 3675, a close coupled version of Figure 3775 with liquid end bolted to the flange faced motor and rotating parts assembled on the motor shaft extension, also comes in 11 sizes and has the same rating. Its maximum temperature is 275 F, working pressure, 275 lb, and hydrostatic test pressure 1100 lb. Both pumps have carbon steel casings, iron or bronze trim. Goulds Pumps, Inc.

10—TREATING SOLUTION makes Teflon, Kel-F bondable

FluoroBond is introduced for treating fluorocarbons to make them bondable. Materials such as Teflon or Kel-F can be made bondable in 15 sec, it is announced, by simple dipping, brushing or spray methods. Excellent bond strengths are reported with no adverse effect on the electrical properties of the material in thicknesses as low as 0.0005 in. The Joclin Mfg. Co.

11—ENCLOSED CABLE SUPPORT for outdoor vertical conduit run

Raintight, enclosed cable support, Type W, is designed for use as an intermediate support for cables in an outdoor vertical conduit run. It can be used for one or more wires, in conduit sizes from 1 to 5 in. Fittings are for use with all types of insulations at all voltages. Sleeves, furnished with the fittings, range from 12 to 18 in. long. Hot-dip galvanized finish is standard. O. Z. Electrical Mfg. Co., Inc.

12—VERTICAL FILE holds single sheets compactly

Advantages of vertical filing with convenience of handling only one sheet at a time are combined in this re-designed vertical file, according to manufacturer, and it saves space, as 150 individual sheets up to 42 in. wide can be filed in only one lineal foot. Each sheet is attached to its own aluminum hanger with aluminum foil adhesive fasteners. The hanger is notched to fit a rack which can be mounted on the wall. Once inserted in the rack, the hanger is secure — yet can be readily withdrawn. Plan Hold Corp.

13—1-IN. VALVE resists effects of erosion and corrosion

Although designed for oil field water flooding service, this 1-in. valve is suggested for use wherever corrosion and erosion are problems. It is described by manufacturer as 1-in. No. 18857 18-8 SMO plug gate valve with screwed ends, and said to offer combined advantages of a gate valve, and a plug disc globe valve. Features announced include tapered non-turning plug disc; stem pinned to disc; hand-wheel attached to yoke sleeve; reduced seat and fine stem threads; O-ring bonnet joint, and a rating of 1500 psi water, oil or gas working pressure. Crane Co.

14—LEVEL WARNING SWITCH works in variety of fluids

This explosion proof, hermetically sealed, low- (or high-) level warning switch is designed for use in almost any liquid. According to manufacturer, the switch

cannot be affected by contaminants in the fluid, or by rolling or pitching motions. It can be installed to warning lights and/or automatic switching mechanisms to start pumps or open auxiliary lines. A time lag mechanism is provided to prevent tripping even when upside down for less than 3 sec. The switch weighs less than 16 oz, operates on any electrical system from flashlight battery to 300 v at 5 amp, temperature from −65 to 250 F. Acme Machine Works.

15—GREASE ADDITIVE offers more coverage per dollar

For greases and heavy oils, this MoS_2 dispersion ('dag' 208) is claimed to provide substantially greater coverage than finest commercially available molybdenum disulfide powder at no increase in solids content. In fact, says manufacturer, greater effectiveness can be obtained at a lower solids content, extending range of applications to closer-tolerance mechanisms. Finer particles in the pre-wetted dispersion provide much greater hiding power, it is explained, and the ultimate result is more coverage per dollar. Acheson Colloids Co.

16—PIPE INSULATION for low temperature applications

Unarco U-200, an insulation product for use at temperatures from −300 to 220 F, is described as a closed-cell synthetic which will not burn and has excellent heat and chemical resistance. Thermal conductivity tests are reported to show Unarco U-200 to have a K factor of only 0.14 at 70 F mean temperature. It is pointed out that a closed cell content of 85 per cent plus gives this insulation a high degree of resistance to water and vapor. Density is 2.3 lb per cubic foot. Despite its light weight, it has high

compressive and flexural strength, manufacturer states, can be cut and applied with standard tools, and is non-toxic and non-irritating. Unarco U-200 comes in half-round sections of nominal thicknesses in standard pipe sizes. Sections are 36 in. long. Fibrous Products Div. Union Asbestos and Rubber Co.

17—METERING PUMP is adjustable capacity unit

Airmatic VC 1000-1, a positive displacement pump, is announced as infinitely adjustable within its capacity range of 0 to 6.44 cc. The pump is suggested for slug feeding of precise quantities of slurries, adhesives, pastes, greases, and other viscous liquids and semiliquids. It consists of a solenoid-actuated pneumatic cylinder and a pumping head, the latter containing inlet and outlet ports and provision for precise limitation of the air cylinder piston's stroke length. Check valves are not integral — they may be placed in the inlet and outlet lines if necessary. It is stated that the Airmatic VC 1000-1 provides precision metering of even heavy-bodied liquids, since pumping

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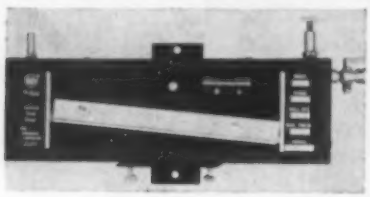
pressure can be as much as 354 psi. Pumping pressure is determined by air pressure (up to 200 psi) and air cylinder bore (1, 1⅜, and 1½ in.). All ports are ¼ in. Solenoids are available for most a-c or d-c voltages, and materials used in pumping head and piston can be varied to suit requirements of the job. Airmatic Valve, Inc.

18—DUCTILE IRON GATE VALVE in sizes from ½ to 2 in.

Utilizing ductile iron's properties and specific design advantages, the Pipe-Pal is rated at 1000 psi for all temperatures from −20 to 650 F. This gate valve is described as having a spread flange design which embodies longer bolts that store extra bolting energy to prevent joint loosening. Ductile iron's strength and shock and impact resistance make this valve well suited for refinery and process lines, according to manufacturer. The Ohio Injector Co.

19—DRAFT GAGES in single- and dual-tube units

For measuring boiler room pressure, furnace and oven drafts and other low pressure phenomena, this line of draft gages includes single-tube models in six ranges, with maximum pressure readings of ½ to 4 in. of water. Dual-tube gages come in four ranges, maximum readings of ½ to 2 in. of water and can be furnished with a different range



for each tube. All have an 11-in. scale. The instruments are furnished for wall or flush mounting, or with base for table mounting. Construction features include a case of heavy formed steel channel, welded to end plates, and front cover with rubber-mounted glass plate. Wetted metal parts may be had in aluminum or 300 series stainless steel. Details are in Catalog 2008. King Engineering Corp.

20—UNDERFLOOR SYSTEMS with more wiring capacity

These two Headerduct Systems are designed for applications utilizing cellular steel floors as raceways for power and communications conductors. One system, the 15,000 Series, provides 20.294 sq in. capacity. The 14,000 Series offers 9.2 sq in. Both are 14-gage steel and can be combined in one installation.

The 15,000 Series duct shown at top of photo measures 2½ by 10 in. and has removable aluminum cover plates designed to butt together to form a cover for the duct and also permit ready access to wiring. An aluminum extension on either side provides a screed line for concrete and finish trim for tile. The duct comes in standard lengths of 3 and 5 ft. The 14,000 Series (bottom of photo) is 1⅝ by 7¾ in., available with junction unit spaced on centers from 12 through 120 in. These junction units

are designed to permit outside adjustment. The duct comes in 8-, 9- and 10-ft lengths. A large-capacity cross box is also available with the 14,000 Series. It provides an 11¼-in. opening allowing access to all four duct exits as well as a 3-by-12 in. opening giving access to the cells of the floor. National Electric Div., H. K. Porter Co., Inc.

21—ALUMINUM WRENCH is light and extra strong

Designed to meet high strength requirements, this wrench is forged from aluminum bar stock and is described as approximately 66 per cent lighter than malleable iron wrenches. It is made of

Kaiser aluminum alloy 2014 and available in six lengths from 10 to 48 in. with jaw capacities of 1½ to 6 in. Standard models have replaceable insert steel jaws. A safety model with non-sparkling beryllium-copper jaws is available, and all models have a tension spring between jaw head and handle. Prices are reported to be comparable to those of similar steel models. Schick Products, Inc.

22—INTAKE AIR UNITS are direct-gas-fired

These direct-fired intake units are claimed to offer almost 100 per cent combustion efficiency for supplying tempered outside air to replace air removed by industrial exhaust systems. Economy is achieved by burning natural or propane gas in a line-of-flame burner directly in the entering airstream. Products of combustion are mixed with large volumes of fresh outside air to avoid possibility of contaminating air in building. Basic models are rated at 2, 4 and 6 million Btu/hr, with air volumes of 25, 50 and 75 thousand cfm. They may be installed on the roof or in a wall opening, and used with or without duct system for air distribution. Standard models have a propeller fan in the airstream, but vaneaxial, tubeaxial or centrifugal fans for external mounting can be supplied. Hartzell Propeller Fan Co.

23—AUTOMATIC RECLOSERS with sequence and timing device

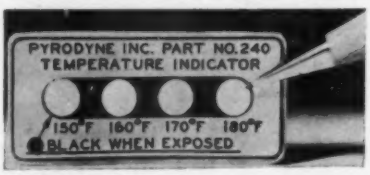
This manufacturer's Type HR Automatic Reclosers now incorporate a sequence and timing device that can be adjusted and changed in the field during routine maintenance. It allows the units to be moved to other parts of a distribution system where operating sequence conditions may be unlike those originally set at the factory, it is announced. Field adjustments are made by adjusting a cotterpin which changes the number of recloser operations. Adjustment of a selector wheel in the cover casting changes time between operations. Use of the new device permits timing sequences to be coordinated with sectionalizing fuses, branch fuses, circuit-breaker relays, internal and external transformer fuses and other hydraulic reclosers. Also announced for these reclosers is use of Thyrite resistors to give between lightning protection and increased reliability. The reclosers come in single- and three-phase units rated 14.4 kv in 50, 100 and 200-amp frame sizes, and 23 kv in 100-amp size. General Electric Co.

24—AUTOMATIC CONTROL for pipe line pumping

For use on gas, gasoline or diesel engines, this program timer is encased in a steel, weatherproof enclosure. The control includes one standard automatic engine control together with a timer driven by a governed d-c motor. All current is taken from the engine battery, no commercial power is required for operation. Engines equipped with the controls can be preset for the length of time, time of day or night and days of the week required to run, as well as time to be stopped. Synchro-Start Products, Inc.

25—PLASTIC LABELS indicate surface temperatures

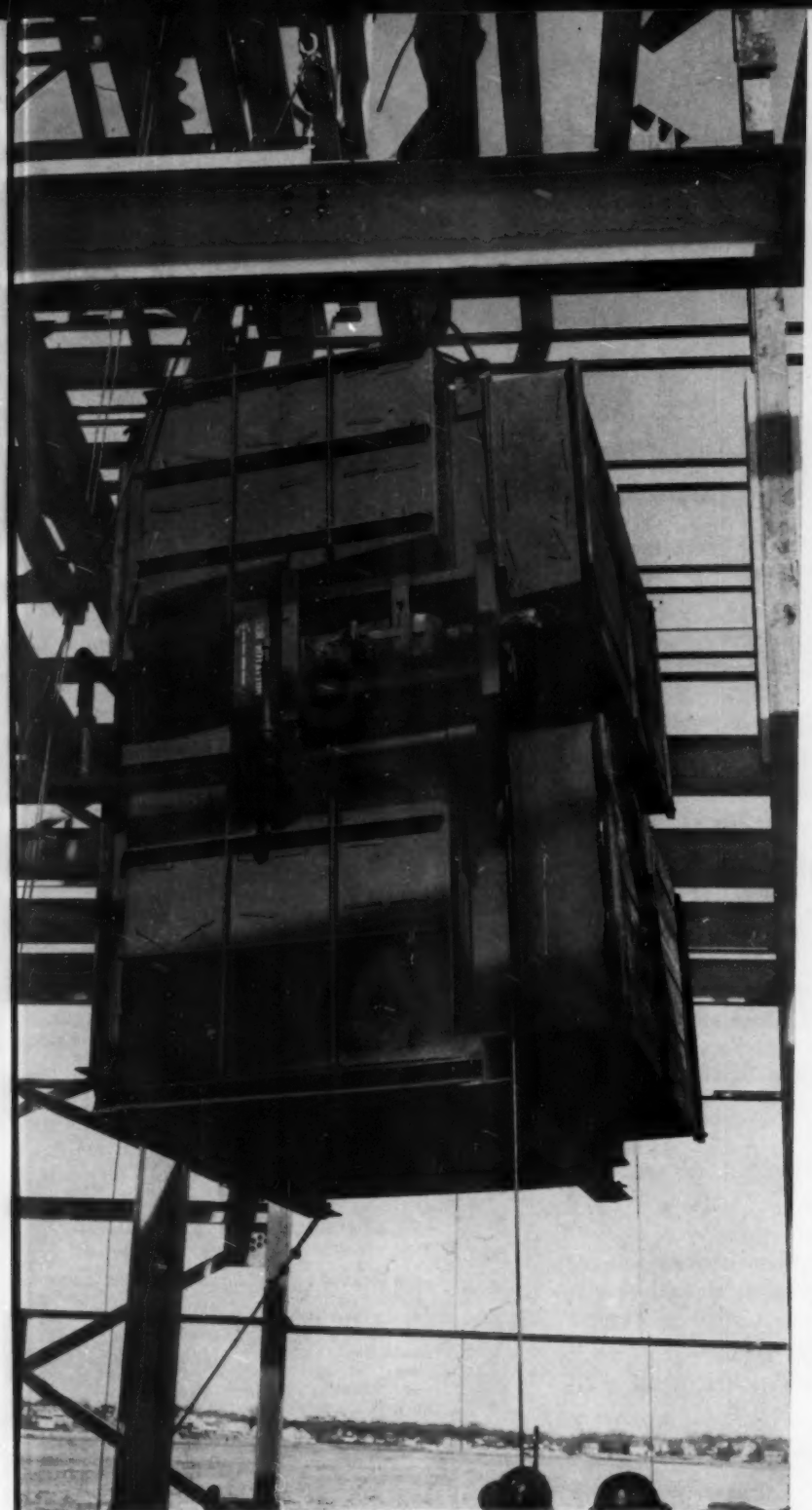
Calibrated to give an irreversible registration of temperature, the Temp-Plate is announced for indication from 100 through 700 F, in a choice of 50 increments, with accuracy of ± 1 per cent.



The small plastic label, backed with adhesive for simple application, is designed to register a permanent change from white to black as the stated temperature level is reached, and to adhere to the mounting surface under a wide range of exposure conditions until unintentionally removed. Pyrodyne, Inc.

26—SUBSTATION FIXTURE has prismatic glass lens top

Consisting of one-piece refractor with removable prismatic lens top, Fixture No. 04252 incorporates arrangements of refracting and reflecting prisms in the lens top and refractor designed to provide maximum utilization of illumination on disconnect switches and other overhead components in outdoor substa-



mplete and ready to run, Package Air Preheater is lowered through steelwork of new wer station at Braintree, Mass. Installation at Braintree Electric Light Dept. uses rgest available package preheater, with a diameter of approximately 12'. Fitted to a 0,000 lb per hr boiler, this Package Air Preheater will boost combustion air tempera- re by about 420°F with heat recovered from stack gas.

PACKAGE AIR PREHEATER

gives twofold economy at Braintree's new power station

PACKAGE DESIGN FACILITATES INSTALLATION; FUEL SAVINGS TO WRITE OFF COST IN 2 YEARS.

Braintree, Mass., has achieved an economic double-header with the Air Preheater in their new power station:

1. Initial saving: The Package Air Preheater, shown above, was delivered as a completely preassembled unit. All it needs is gas ducts and a power line and it's ready to work—installed at a fraction of the time and cost required for conventional units.

2. Long-term savings: Records prove that Braintree's Package Air Preheater can pay for itself—just on fuel savings alone—within two years.

Package design gives you these advantages on boilers as small as 25,000 pounds of steam per hour —or as large as 250,000 lbs per hr. And a Package Air Preheater is one of the surest ways to reduce fuel consumption: you cut your fuel bill 1% with every 45-50°F increase in preheated air temperature.

Get all the facts. Write today for your copy of the free 14-page booklet describing the multiple savings you get with a Package Air Preheater.

THE AIR PREHEATER CORPORATION

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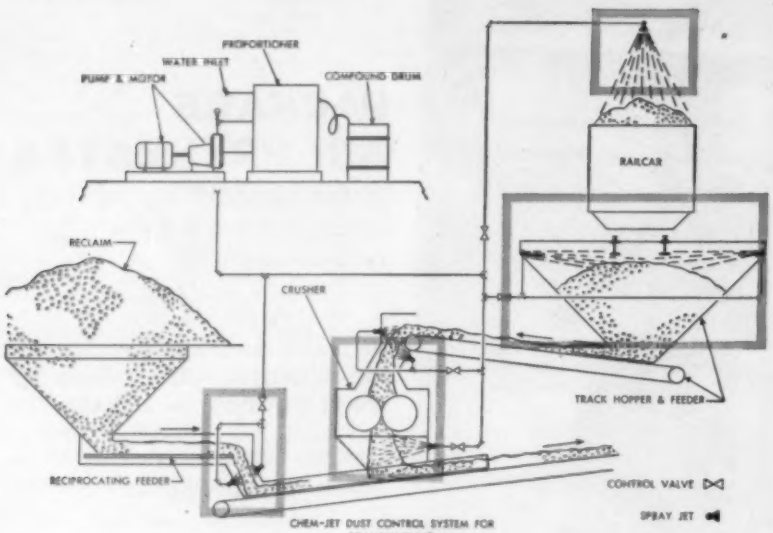
JOHNSON MARCH chem-jet DUST CONTROL SYSTEM



COAL DUST IS CONTROLLED at strategic points by Chem-jet system engineered for efficient, low-cost operation. Schematic diagram of Chem-jet system at large southern power company.

COAL HANDLING DUST STOPPED AT ITS SOURCE BY CHEM-JET

THE ONLY SYSTEM OF ITS KIND, Johnson-March Chem-jet is the low-cost dust control system that attacks a dust problem at its source . . . Chem-jet stops dust *before* it becomes airborne.

- Low-Cost Dust Control—
  Chem-jet means low first cost, low operating cost, minimum maintenance.
- Each Installation Engineered—
  Maximum effectiveness in dust control is assured because each system is designed to solve specific problems.
- Coal Treated With Compound M-R—
  Ends dust problem and eliminates the hazard of fire and dust explosion.

Engineering analysis of your dust problem will be made in your plant at no obligation.

JOHNSON MARCH DUST CONTROL ENGINEERS

3018 Market Street, Philadelphia 4, Pa.

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tions. Manufacturer points out that former designs of outdoor units were limited to lateral light distributions with maximum candlepower peaking at 105 or 15 deg above horizontal. This new unit produces two peaks of maximum candlepower, one at 105 deg and another at 180 deg, or directly above the fixture. With it, any substation can be lighted effectively, it is claimed, regardless of height of disconnect switches, and shadowless illumination is provided for equipment in the range of 25 to 100 ft above ground. Ease of installation and maintenance are promoted through use of a slip fitter fixture base assembly for bracket or post top mounting, and a removable top lens assembly. Two stainless steel latches secure lens top to refractor body and, when relamping is necessary, these latches are tripped open by hand. Holophane Co., Inc.

27—AFTER COOLER cools and dries compressed air and gas

Improved models of the Aero After Cooler are announced as giving increased capacity in more compact equipment because of improved cooling coil and manifold design. These machines obtain the cooling and drying effect by evaporative cooling of compressed air passing through tubes over which a water spray is partially evaporated. Heat of compression is rejected out of doors in an air stream passing through the spray chamber. Compressed air is cooled to a temperature approaching that of the ambient air to assure no further water condensation in compressed air service lines. A separate water cooling coil is included for compressor intercooler.

The operation is controlled by an air by-pass and recirculation system that varies the amount of outdoor air passing through the spray chamber, adjusting capacity to the load and protecting the sprays from freezing in winter. New Models include a trap in the manifold to remove condensed water. The after cooler comes in nine sizes with a range of free air capacity from 200 to 12,000 cfm. matching compressor sizes from 40 to 2500 hp. Manufacturer states that cooling water consumption is less than 5 per cent of that used in direct-surface-contact methods. Niagara Blower Co.

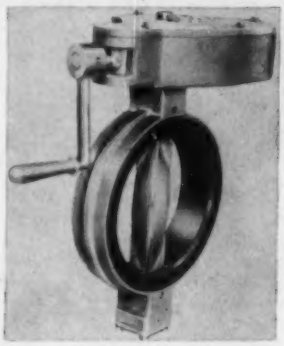
28—COMBUSTION SAFEGUARD for gas-operated burners

Continuous supervision of gas-operated burners in boilers, furnaces and other equipment is the function of the Protectofier. This control is designed to prevent fires or explosions from build-up of combustible fuel mixtures in single- or multi-burner installations. Features announced include compactness and low overall costs — due to elimination of many duplicated components and subsequent wiring. A plug-in assembly, called a Flame-Pak, contains the entire electronic circuit (one for each burner). Any practical number can be used with a single Protectofier to accommodate multi-burner installations. If a flame failure or fault occurs at any burner position, the signal from the flame electrode to its corresponding Flame-Pak is interrupted — this serves to break the circuit to the safety shut-off valve, and stop fuel flow to all burners in the system. An unusual advantage noted for this system is elimination of critical flame adjustments. Electrodes can even be immersed

through the center of the flame without causing unstable operation, it is claimed, and this also permits use of a single electrode as both igniter and flame-sensing unit. Protection Controls, Inc.

29—BUTTERFLY VALVE, high pressure, rubber seat

Economy as well as several technical innovations are announced for the Monoflange Mark II line of high pressure, rubber seat butterfly valves. They

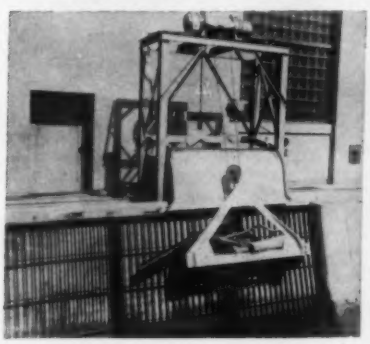


are offered for 150 psi tight shutoff in sizes 4- through 20 in. A wide range of material trim and valve actuators for manual or automatic operation are offered. Bulletin 10-G gives details. Henry Pratt Co.

30—TRASH RACK RAKE clears clogged water intakes

For removing leaves, grass, roots, branches etc., from trash racks protecting water intakes at power, sewerage and water supply plants, the Leonard Trash Rake can be used on stationary intake rack structures which have either inclined or vertical rack bars. An advantage noted is ability to ride down over stubborn obstructions and work them free. Easy cleaning of the bars is reported because no guides at the rack bars are needed.

An electric hoist raises and lowers the rake. When descending, the rake's teeth automatically turn upward parallel with the rack bars to clear debris. When ascending, the teeth tilt to a position perpendicular to racks and penetrate between them to carry debris to the unloading position. Removal of floating trash is speeded as the rake teeth rotate to the proper position without approaching either extreme of rake travel. Company points out that initial cost of the equipment is kept low by having the trash rake operate directly



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Kansas City 5, Mo.
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- ☐ scale, corrosion, or foaming in my boiler operation
- ☐ rust and corrosion in my steam and condensate return lines
- ☐ scale, corrosion, or algae growth in my cooling or condenser water system
- ☐ corrosion or scale in my potable or plant water supply lines and tanks
- ☐ rust and corrosion in my brine or sweet water system
- ☐ scaled up pumps, water jackets, compressors, coils, lines, or equipment
- ☐ sludge and moisture in my fuel oil supply
- ☐ soot deposits in my furnace combustion areas

"I'd like to know..."

. . . exactly what specific treatment your Technical Services Dept. recommends. I understand that such problems have been your specialty for over 65 years and that you have an outstanding record for restoring and maintaining efficiency of plant equipment through advanced chemical treatment. Will look forward to receiving in the near future both your latest technical literature *and* a personal letter concerning my problem. I understand that my inquiry involves no obligation.

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WESTERN CHEMICAL COMPANY

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Never before has the Henry Pratt slogan "Creative Engineering for Fluid Systems" been more aptly proven as truth—for creativity and experience have combined with a most sophisticated result—the totally new MONOFLANGE MK-II.*

Stemming from four years of laboratory and field development, this compact and sensible valve will impress and delight those with a feeling for quality and economics.

The Monoflange MK-II is a versatile valve with a wide variety of sizes, materials, and operators—among which is the all new SIDEWINDER®, a totally enclosed manual operator designed to be the perfect mate for the MK-II.

We believe this is a significant contribution to the valving art—one which will establish a new trend in the low price field. You will want one to test for yourself.

Write for bulletin 10 G

Monoflange® MK-II
RUBBER SEAT BUTTERFLY VALVE

HENRY PRATT®

*Important things are happening at the Pratt Research Laboratories—as evidenced by this new product, the first of a series to be announced as part of the new line for 1960.

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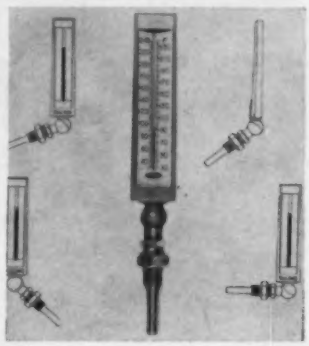
on rack bars. It is not necessary to provide channel guides embedded in concrete piers at each side of the intake or attach the guides to the rack bars. Hence, the width of the rake can be nominal size. Allis-Chalmers Mfg. Co.

31—INDUSTRIAL THERMOMETER adjusts to any viewing angle

The Princo MultiForm can be turned or tilted to the most favorable reading position after stem is in any place, and locked in that position. Its locking device is designed to allow for reset to any



desired form should the thermometer have to be moved or repositioned due to a change in piping. In this instrument the tube is recessed between a two-piece scale to eliminate parallax, while the red reading mercury tubing is seen against a baked white enamel scale. The case is cast brass or aluminum. The thermometer is available with any standard SAMA separable socket or with exposed bulb and perforated stem construction. Precision Thermometer & Instrument Co.

32—A-C VOLTMETER is small enough for limited-space use

Model 332 is a pocket-sized a-c electronic voltmeter for applications where space is extremely limited and sensitivity not too important. Panel mounted, it uses a 2½-in. meter and has a barrel only 2 in. in diameter and less than

4¾-in. long. With a basic range of 0 to 100 millivolts rms, Model 332 is suggested for applications of medium sensitivity where a straight a-c voltmeter is ruled out because of low input impedance. Input impedance of Model 332 is 1 megohm, paralleled by 10 micro-microfarads, so that it adds almost no load to the circuit being measured. It can be

provided with any voltage range to 300 v rms. Frequency response is 20 cps to 20 kc, ±2 per cent, with accuracy given as ±3 per cent of full scale deflexon. Metronix, Inc.

33—GATE VALVE offers quick and easy operation

Redesigned Bronze Quick-Opening Handy Gate Valve, Fig. 430-58 is announced as providing tight shut-off against flow from either direction, yet affording quick and easy operation. It has a ball-and-socket joint between self-adjusting faces, and a deep stuffing box seals the operating stem. End-to-end dimensions are unchanged, maintaining the

valve's interchangeability. The cap is bolted down with two cap screws to facilitate disassembly. Available in sizes ½ through 4 in., these valves are rated 75 lb steam pressure for water, oil or gas and are suggested for installations where quick operation is required to handle water, oil and low pressure steams. The Lunkenheimer Co.

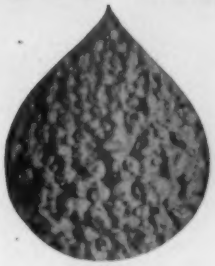
34—MOTOR CONTROLS serve twin pump installations

Type DP Duplex Pump Controls — combination and non-combination — are for control of motors on twin pump installations where two pumps operate individually or in conjunction to provide necessary pumping operation depending on pumping rates required. These controls provide a disconnect means for every motor, either through use of a disconnect switch, fusible or non-fusible, or a thermal magnetic trip circuit breaker placed in series with the starter and load. DP Duplex Pump Controls have the front operated mechanism mechanically interlocked with the cover of the enclosure, making it necessary to disconnect circuit before door can be opened. Non-combination types consist of two Type RA magnetic starters and single Type MR relay for electric alternating mounted in one enclosure. Starter components feature straight-through front wiring and a right angle operating mechanism which allows reductions in size and weight.

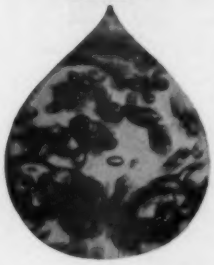
All of the control panels feature under-voltage release. Should the power fail on a two-wire control system, the electro-magnet is automatically de-energized since there are no holding circuit interlocks. On resumption of power, the electro-magnet is automatically energized without the aid of the operator. This, it is stated, prevents stalling or overheating on low voltage and lets pump panel be left unattended. The Arrow-Hart & Hegeman Electric Co.

CONCENTROL
PROVIDES
LOW COST, EFFECTIVE CONTROL of FOAM and BOILER WATER CARRY-OVER

PROVED IN THE LAB:

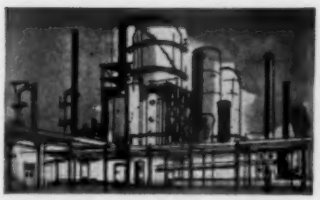


BEFORE: Foaming of highly alkaline solutions in glass test cylinder.



AFTER: Same solution after addition of 12 ppm of Bird-Archer Concentrol antifoam.

PROVED IN THE FIELD:



Concentrol eliminates foaming, maintains dissolved solids of 10,000 ppm with alkalinity in excess of 2,000 ppm in East Texas refinery.

Concentrol reduces blowdown rate from 15% to 5%, keeps steam quality high in paper mill using highly alkaline makeup water.

Concentrol eliminates boiler carry-over caused by high alkalinity for an automobile radiator manufacturer using a carbonate water that is Zeolite softened.

Concentrol is available in liquid, powder or briquette forms. Fast acting and resistant to hydrolysis or breakdown under normal boiler temperatures and pressures, it can be fed either continuously or in slugs to boilers. Many plants get the advantages of positive foam control *plus* boiler water sludge conditioning by using Concentrol in combination with organic sludge conditioning agents.

Let a Bird-Archer Water Treatment Engineer prove what Concentrol can do in your plant.
Bird-Archer is always as near as your phone.

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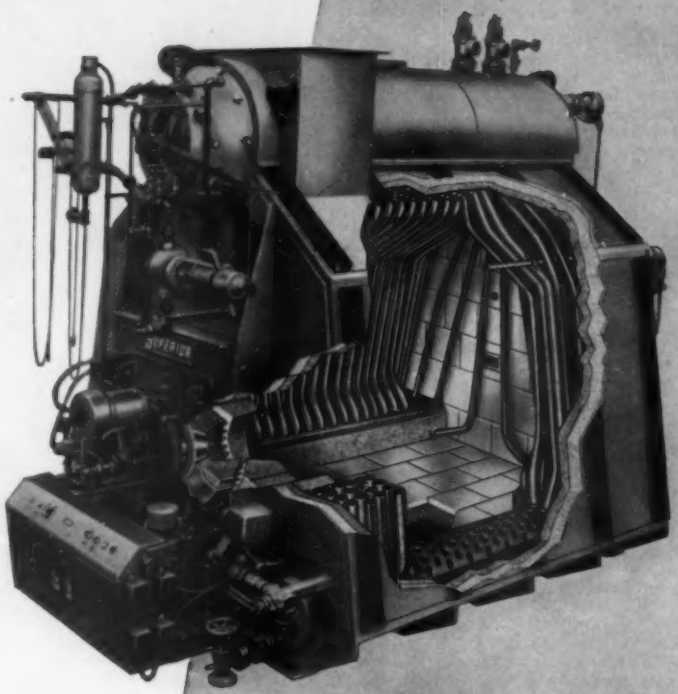

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Tangent tube water wall furnace, promotes rapid circulation, fast steaming and eliminates maintenance necessary where refractory type baffles are used. All furnace wall tubes are riser elements discharging directly into the main steam drum.

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WATER CONDITIONING

201 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 16-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

202 Deserting Heaters — Twelve-pp Bulletin WC-106A on tray type deaerating heaters covers principles of deaeration, tray heater operation, standard heater design and applications, accessory equipment, and design and fabrication of tray utility heaters. A section on design features discusses load variations, installation, metallurgy and construction of trays. Graver Water Conditioning Co.

203 Coagulant Aids — Featured in this product bulletin is a line of coagulant aids designed to improve floc formation in clarifying and softening water. Advantages are detailed and typical applications described. Calgon Co., Div., Hagan Chemicals & Controls, Inc.

204 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 3006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

205 Steam System Treatment — This bulletin on Corsavol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Corsavol process) and presents case histories of use in different types of plants and industries. Corsavol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

206 Corrosion Protection — The problem of corrosion protection for steam and condensate return lines is discussed in this product bulletin. Company's amine treatment of condensate systems is described and advantages detailed. The Bird-Archer Co.

207 Corrosion Control — Process Bulletin B6 describes company's condensate system corrosion inhibitors for protection of return lines, steam turbines, tanks and heaters. Discusses causes of condensate system corrosion and tells how inhibitors overcome them. Nalco Chemical Co.

208 pH and Chlorine Control — The 14th, 1969 edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide compara-

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tors and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

209 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

BOILERS, GENERATORS

210 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

211 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room. Cyclotherm Div., National-U. S. Radiator Corp.

212 Hot Water Boilers — This 20-pp Brochure HCC-2 describes and illustrates design, construction, advantages and economics of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and process uses. Combustion Engineering, Inc.

213 Boilers for Many Services — This general product data catalog in loose-leaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams it provides tabulated engineering data. Industrial Div., American-Standard.

214 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

215 Packaged Generators — Bulletin MH 3-54, 14-pp, gives detailed coverage to company's Type MH packaged water tube steam generators which are furnished for oil or gas firing or both, with automatic, semi-automatic, or manual controls. Included are: cutaway illustrations, installation photos, tube arrangement layouts, construction details, auxiliary equipment, dimensions. Union Iron Works.

216 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per

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hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

217 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr. at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

PUMPS, COMPRESSORS

218 Proportioning Pumps — Catalog 604, 8 pp, covers details and specifications of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are given. Hills-McCanna Co.

219 Low Pressure Compressors — Eight-pp Bulletin A-95 describes a line of low pressure compressors for heavy duty industrial applications. Engineering design features are detailed and advantages explained. Joy Mfg. Co.

COAL AND ASH HANDLING

220 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features. American Pulverizer Co.

221 Hydraulic Shakeout — Bulletin 658 describes and illustrates the Carquake, hydraulically powered car shakeout designed for maximum car shaking with minimum noise. Rail- and stationary-mounted types are shown. Six advantages detailed. Stephens-Adamson Mfg. Co.

222 Coal Sample Crusher — How you can save on your fuel bill and power cost with company's coal sample crusher is explained in Bulletin CS2. Illustrated with photos and dimensional diagrams, discusses briefly the equipment's operation and features. Gruendler Crusher & Pulverizer Co.

223 Car Dumper — Sixteen-pp illustrated Brochure 957 describes a rotary car dumper capable of handling hopper and gondola cars and equipped with clamps which hold the dumper car without counterweights. These and other design features are explained and installations pictured. Heyl & Patterson, Inc.

224 Crab Buckets — Bulletin RD-1 describes a line of grab buckets designed for handling coal, ore and other bulk materials. Details of operation and design are covered and illustrations of various models in line included. McKiernan-Terry Corp.

FUEL BURNING EQUIPMENT

225 For Burning Refuse Fuel This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses various components. Riley Stoker Corp.

226 Firing Units — Bulletin 28 describes steam atomizing packaged firing

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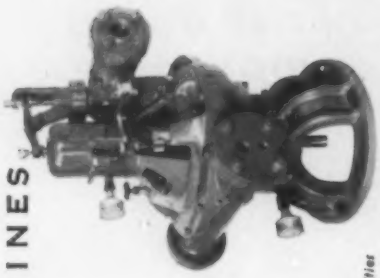

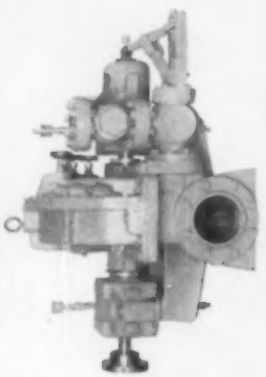

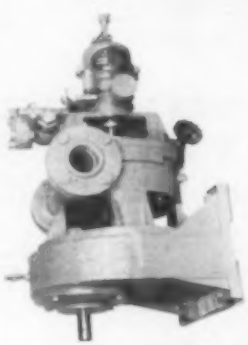

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units for oil and/or gas fuels. Gives advantages of the units, specifications and general dimensions, and other data. National Airoil Burner Co., Inc.

227 For Low-Pressure Heating — Guide Specifications GS-1, 59 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

228 Water-Cooled Stoker — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

229 Spreader Stoker — Catalog 860 contains 20 pp of detailed information on company's overthrow rotor type spreader stoker for boilers of medium size up to 60,000 lb steam per hr capacity. Describes features of design and operation and illustrates applications. Detroit Stoker Co.

REFACTORIES

230 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

231 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

VALVES, TRAPS, AND PIPING

232 General Service Valves — Twenty-pp Bulletin E-165 is a guide to valves for general services. Types, typical applications, construction and operating features are discussed. Generously illustrated with drawings, photos and cutaways, booklet includes dimensional data. Everlasting Valve Co.

233 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

234 Forged Steel Valves — Featured in comprehensive Catalog F-10 is detailed information and engineering data on company's line of forged steel valves, fittings, flanges and unions. Includes photos and cutaway views illustrating component features, as well as tables giving dimensional data. An engineering design section with complete specifications and pressure-temperature tables is included. Henry Vogt Machine Co.

235 To Get at Those Valves — This little folder describes a sprocket rim with

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chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

236 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

237 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

238 Steam Trap Book — Catalog K 48-pp is a manual of steam trapping practice. It includes a section giving physical data and prices on OF& T traps, cast semi steel and forged steel inverted bucket steam traps, compound traps, ball float air and air relief traps. A handbook section explains how to calculate condensate load, and select traps for all classes of equipment; a maintenance section explains trap installation, testing, and maintenance. Armstrong Machine Works.

239 Swing Joints — Eight-pp Catalog 400-A describes a line of ball bearing type swing joints specifically designed for loading and unloading lines handling oils and gasoline, gas and many chemicals. Dimensions and specifications are included, applications detailed. Barco Mfg. Co.

240 Expansion Joints — Advantages and features of company's line of expansion joints designed to prevent excess stresses due to expansion and contraction, to counteract vibration, and to insulate against noise are detailed in this 12-pp bulletin. Typical expansion joint installations are diagrammed and tables of dimensional data included. Goodall Rubber Co.

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241 Flexible Hose, Bellows — Sixteen-pp Catalog 187 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specifications of individual applications. Flexonics Corp.

LUBRICATION

242 Organized Lubrication — Benefits of organized lubrication are extolled in this 24-pp bulletin. Cost control opportunities are detailed and the task of assigning responsibilities and delegating authority in an organized lubrication system discussed. Method of determining savings and setting up records to measure results is also covered. Texaco, Inc.

243 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. Standard Oil Co. (Ind.)

TUBING AND ACCESSORIES

244 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

245 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

246 Aluminum Tube — This 32 pp catalog contains detailed information on company's drawn aluminum tube and extruded aluminum tube and shapes. Describes special features of the metal, metallurgical aspects, mechanical, physical and chemical characteristics, tolerance standards and extrusion definitions. Wolverine Tube, Div. Calumet & Hecla, Inc.

247 Tube Expander Drives — Data on Torq-Air-Matic automatic tube ex-

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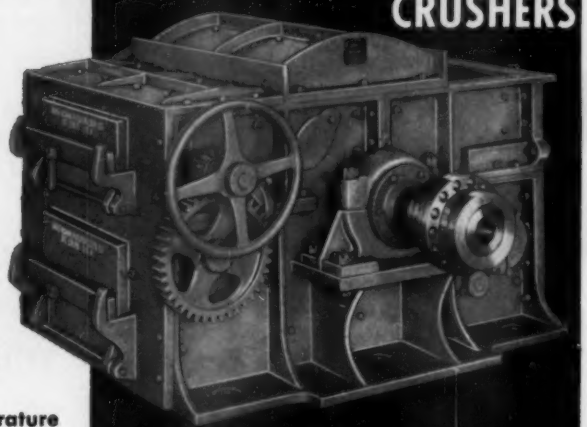

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pander drives, including heavy-duty models, is provided in illustrated 6-pp Bulletin 581. A selection chart lists three basic models, for condensers and evaporators, for heat exchangers and for boiler tubes. Thomas C. Wilson, Inc.

248 Tube Expanders — Bulletin Y-49 contains 12 pp of data on tube expanders designed to make a good hydraulic (or pneumatic) and mechanical seal between tube and tube sheet. Dimension and specification tables included. Elliott Co.

249 Tube Cleaners — Bulletin G-515 describes company's line of air, steam and water driven tube cleaners and accessories. Photos of the various types of cleaners are included, along with descriptive details and specification data. Elliott Co., Roto Plant, Div., Carrier Corp.

MECHANICAL POWER TRANSMISSION

250 Worm Gear Reducers — Complete horsepower and torque data for company's worm gear units built on 2½ up to 4-in. centers are given in full-page tables in Bulletin 5018. Dimensions are diagrammed and tabulated in detail, and materials and design of interchangeable components are described. De Laval Steam Turbine Co.

251 Self-Aligning Coupling — Featured in illustrated Bulletin 273-M50 are company's self-aligning forged steel couplings designed to transmit maximum torque indefinitely. A cutaway view showing component features and tables of ratings are included. Koppers Co., Inc.

252 Power Transmission Equipment — Bulletin 7900-BIP, 12 pp, is designed as a general catalog on mechanical power transmission equipment. Contains selection charts for heavy duty QD sheaves, light weight and QD Junior sheaves, V-belts, and variable speed drives, including all-speed drives, motor drives, and pulleys. Worthington Corp.

INSTRUMENTS, CONTROLS

254 Controls Data — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

255 Ideas on Push-Pull Controls —Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

256 Ion-Exchange Controls — Bulletin E-158 describes automatic control systems for ion-exchange equipment. Standards designed to assure proper performance of control units are detailed, and various elements in the control cabinets, as well as the power-operated units, are described. Specifications for electrical controls are also included. Illinois Water Treatment Co.

257 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

258 Resistance Temperature Detectors — In 8-pp Publication 3016D is described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operations, application and construction details of the resistance temperature detectors are presented. Instrument Div., Thomas A. Edison, Inc.

260 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

261 Metering, Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

surge pressure protection with SILENCE for the *Dramatic* INLAND STEEL BUILDING CHICAGO, ILL.

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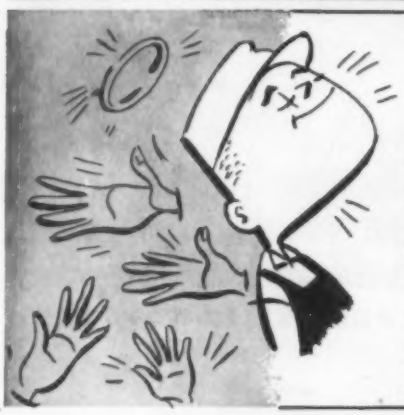

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262 Colorimetric Analysis — Eight pp Bulletin 1156-1 describes industrial instruments available for colorimetric determination of trace quantities of substances dissolved in liquid process streams. Gives details on analyzers for dissolved silica, dissolved oxygen and total water hardness, and includes schematic diagrams. Milton Roy Co.

263 Auxiliary Alarm Facility — Bulletin C6 describes Eye-Hye remote reading gage with electrode and relay adaptation which actuates auxiliary audible or visible signals at high or low water levels. Reliance Gauge Column Co.

OTHER EQUIPMENT

264 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

265 Freon Solvents — Applications of Freon solvents for hand-cleaning operations as well as in degreasing equipment are detailed in this product bulletin. Properties of Freon solvents are tabulated and advantages pointed out. E. I. du Pont de Nemours & Co.

266 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse of Fustat is installed. Book provides wiring diagrams, motor tables. Bussmann Mfg. Co.

267 Story of Coal — This pocket-size booklet presents a complete picture of company's operations, traces the history of the coal industry and describes the many services and applications of coal. A colorful mural reproduced in the booklet pictures the part coal has played in civilization. Peabody Coal Co.

268 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

269 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, fittings. Union Asbestos & Rubber Co.

270 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multi-stage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

271 Fuel Oil Additive — Described in this product sheet is an additive for boilers suffering from "tired" fuel oil. Advantages and characteristics are detailed. Kor Corp.

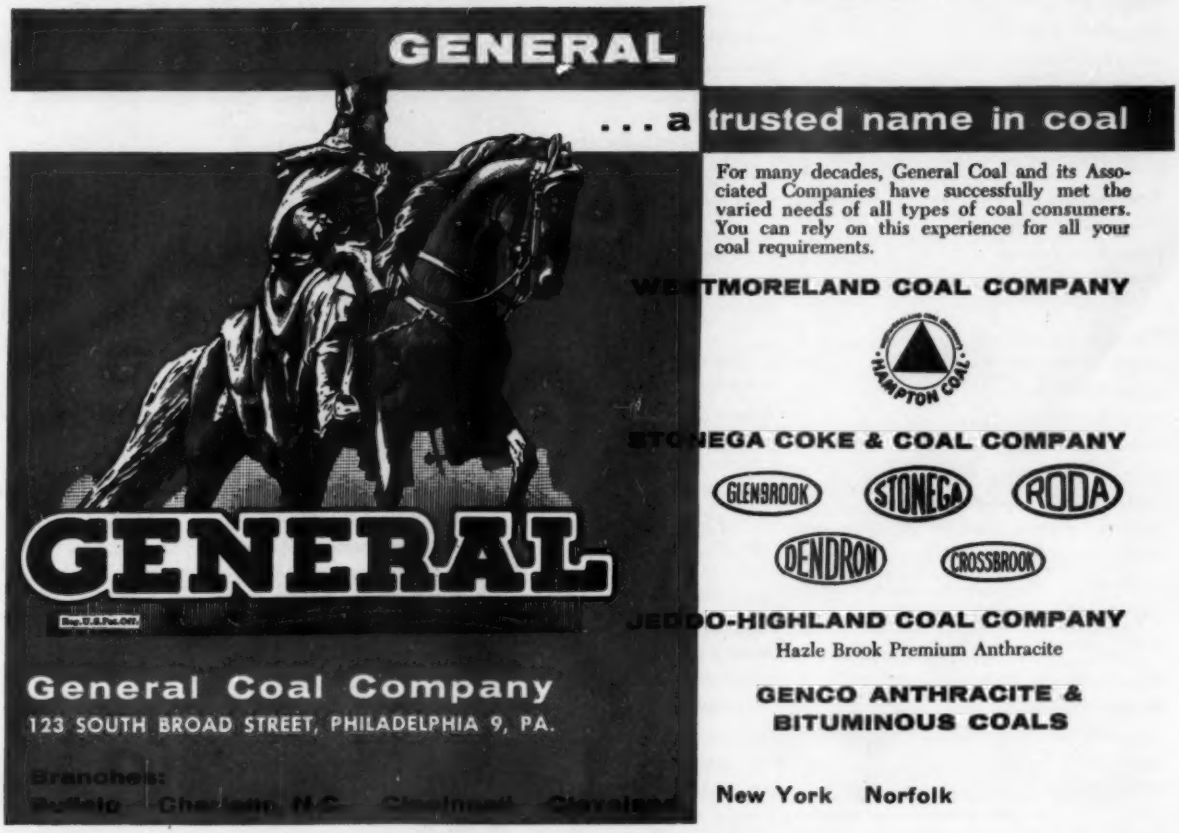
272 Air Preheater — Featured in this 14-pp booklet is a line of package air preheaters for small boilers and process applications. Fuel savings data is presented, as well as diagrams of typical arrangements, and other details of design and operation. The Air Preheater Corp.

273 On Model Studies — Advantages of model studies for precipitators and other gas handling systems are presented in this 18-pp brochure. Discusses three plans under which this new engineering service is available. Several case histories are detailed to show benefits obtained. Also provided are articles on the subject reprinted from POWER ENGINEERING and other publications. Research-Cottrell, Inc.

274 Desuperheater — Bulletin 1024-A describes features and advantages of a desuperheater designed to reduce high steam temperatures. Specifications are included in the bulletin. Copes-Vulcan Div., Blaw-Knox Co.

275 Vapor Condenser — Bulletin 139R contains details on operation of company's sectional vapor condenser. Operations diagrams are included, as well as a graph showing capacities in lb/hr condensate. Niagara Blower Co.

276 Expanded Metal Partitioning — Advantages of expanded metal partitioning are detailed in this illustrated bulletin. Various types of fittings are shown and details of design described. The Globe Co.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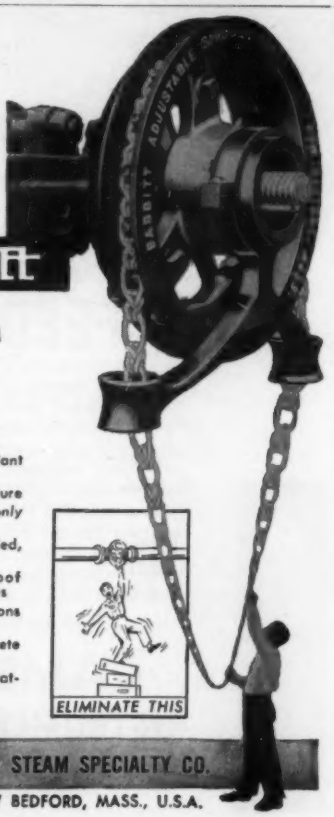
Adjustable

SPROCKET RIM

with Chain Guide



- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance, first cost only cost
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- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
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Babbitt STEAM SPECIALTY CO.

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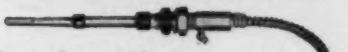
Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

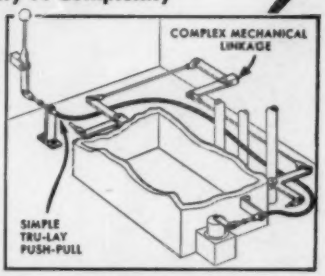


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

Immunity to Vibration makes these TRU-LAY PUSH-PULLS ideal as Remote Controls on shakers and other vibratory products.

Complete Protection Against Dirt and Moisture is a big factor in the use of this unit on machinery in Coal Mines, Cement and Steel Mills, Oil Fields and in many other industries.

Corrosion-Resistance of the unit, plated or with Stainless Steel construction as required by the use, has led to many applications in the Marine Field . . . salt water or fresh. Supplied with a rubber cover the unit operates effectively even when conduit is COMPLETELY IMMERSED.

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Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

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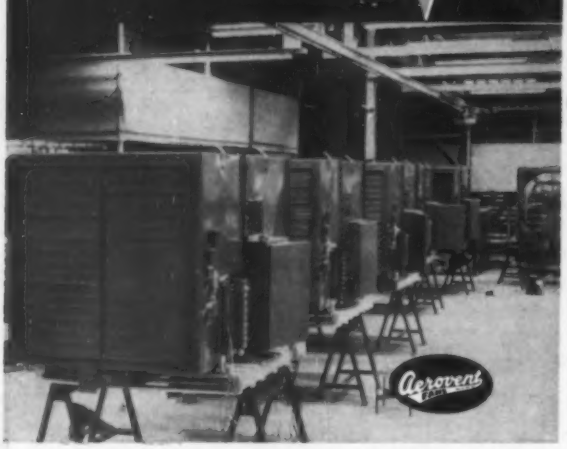
increase production capacity . . .
improve fan and heating efficiency

with

gas-fired air make-up units



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Aerovent

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Smooth seating surface – rotating valve disc changes to new seating surface with every pump stroke.

Reduced flow resistance – accomplished by Sims inclined seat-ribs.

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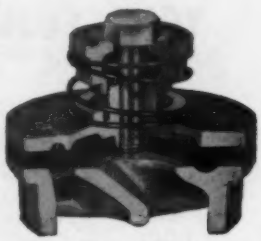

Write for Bulletin V-112 explaining how Sims Valves can improve your pump operation at lower cost.

Sims **PUMP VALVE CO., INC.**

1314 PARK AVENUE, HOBOKEN, N. J.

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detect O_2 in FEED WATER

Continuous records of the oxygen dissolved in boiler feed water and of the hydrogen entrained in steam, indicate when corrective measures are necessary to prevent otherwise unsuspected and costly corrosion. Cambridge Analyzers measure and record dissolved oxygen directly. The hydrogen in the steam is measured and indicates the quantity of oxygen set free by dissociation. Cambridge Instruments are available for continuously recording either O_2 or H_2 separately, or O_2 and H_2 simultaneously.

Send for Bulletin 148 B.P.

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Pioneer Manufacturers of Precision Instruments

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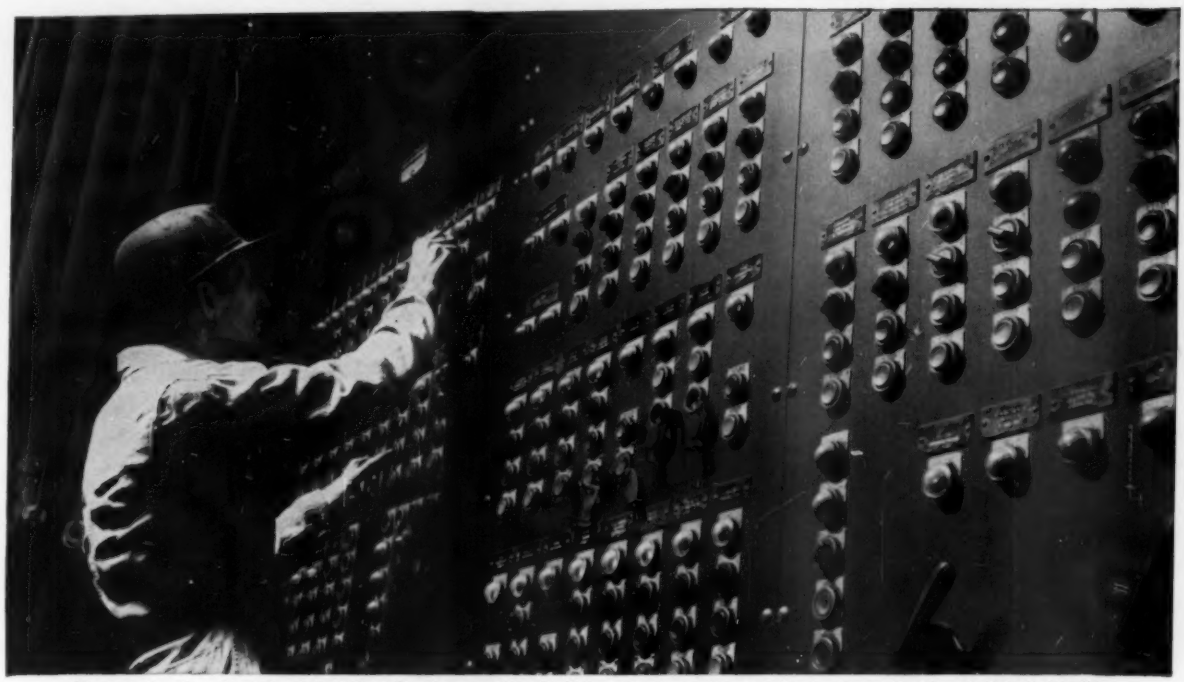
More and more **coal** buyers are checking the net cost per **1000 pounds of steam**

Result: More and more specify Island Creek the coal that's **Precisioneered***



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* PRECISIONEERING at Island Creek is many things. Essentially, it is starting with superior seams of eastern coal . . . and manufacturing it to the exact specifications *your* burning equipment requires to produce steam at the lowest net cost per 1000 lbs. This involves the use of precision engineering techniques in the most modern preparation plants. It involves strictest laboratory controls. It involves far-reaching engineering service and evaluation studies. From start to finish it involves the *career company attitude* that has made Island Creek a leader to whom other leaders may look—with confidence. We'd welcome a chance to get down to *net* costs—with you and your plant people. Write. Or phone. No obligation, of course.

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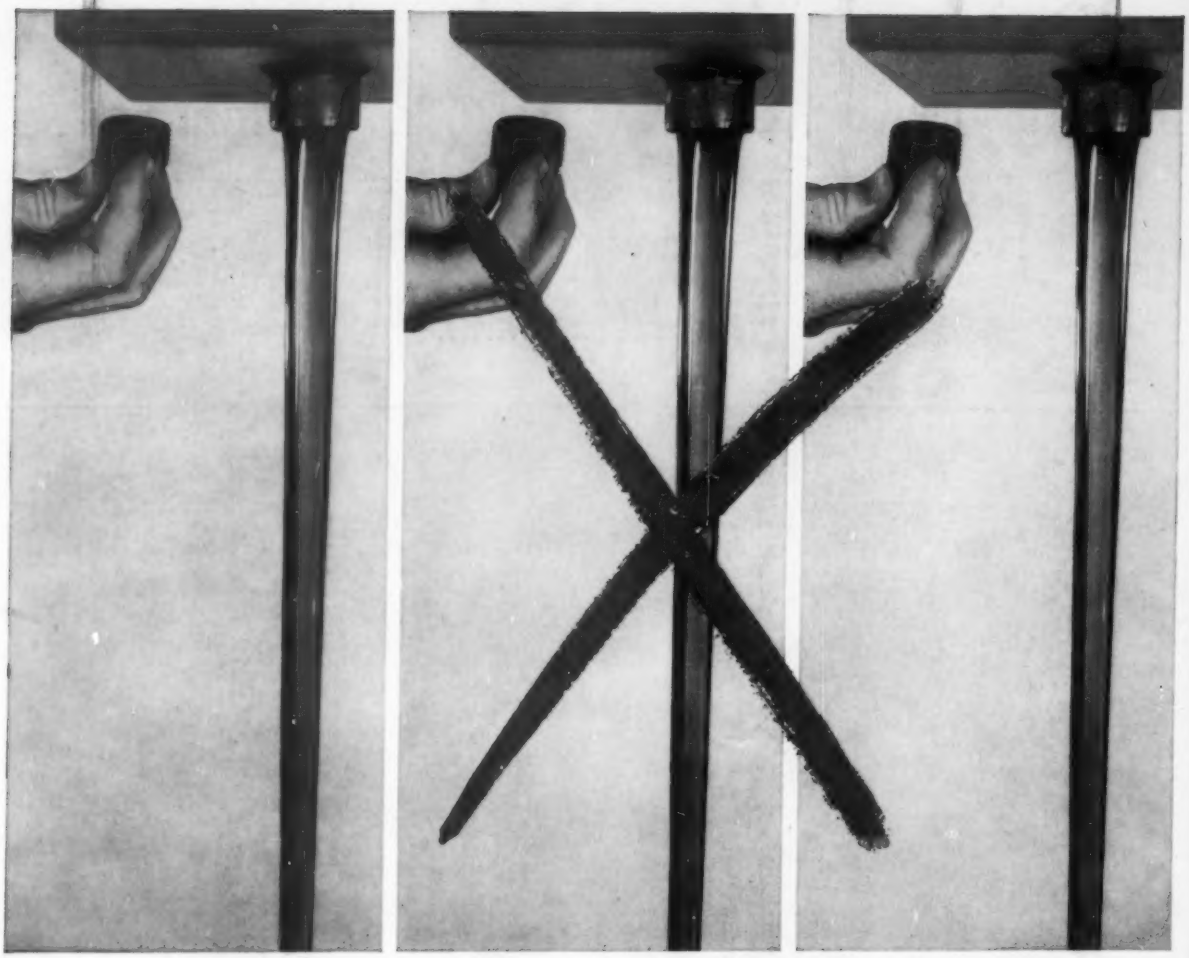

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yet improve hydraulic performance!

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This has been proved time and again when the switch has been made to Texaco Regal Oil R&O without altering any other operating conditions.

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And there's a bonus! When you do drain, you'll find the system in cleaner condition. Save again on make-ready.

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